

June 1996

Mobile Radio TechnologyTM

Technical information for paging, SMR and private wireless networks.

- 
- A technician wearing a red jumpsuit is seated inside the cab of a yellow vehicle, likely a fire truck. The technician is focused on a piece of electronic equipment, possibly a radio or control panel, which is mounted in the cab. The technician's hands are visible, and they appear to be adjusting or working on the device. The background shows the interior of the vehicle, including the steering wheel and other controls. The overall scene suggests a professional setting where mobile radio technology is being applied.
- Flex paging
 - Radio installation
 - Microwave servicing
 - Product/services showcase

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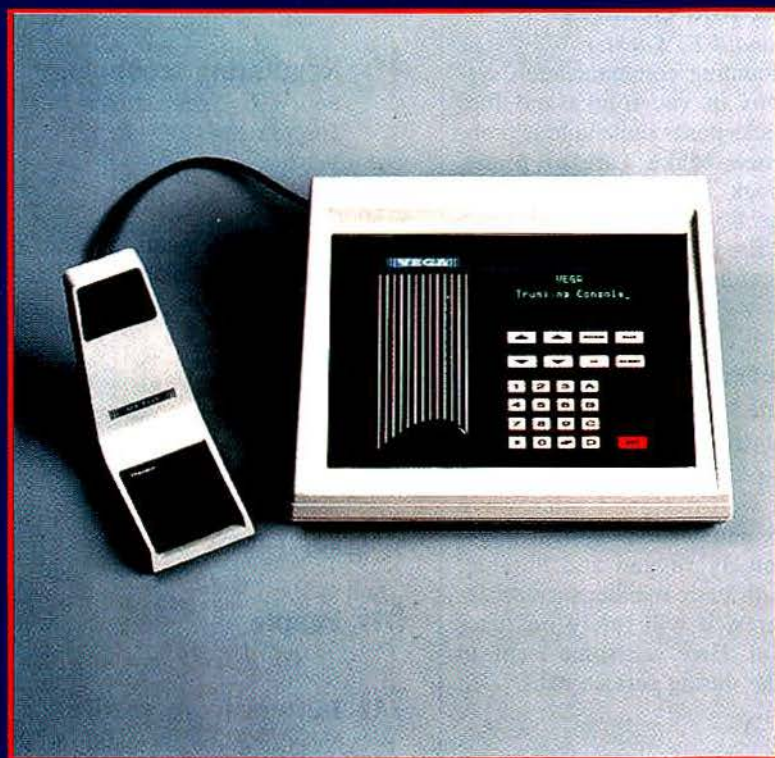


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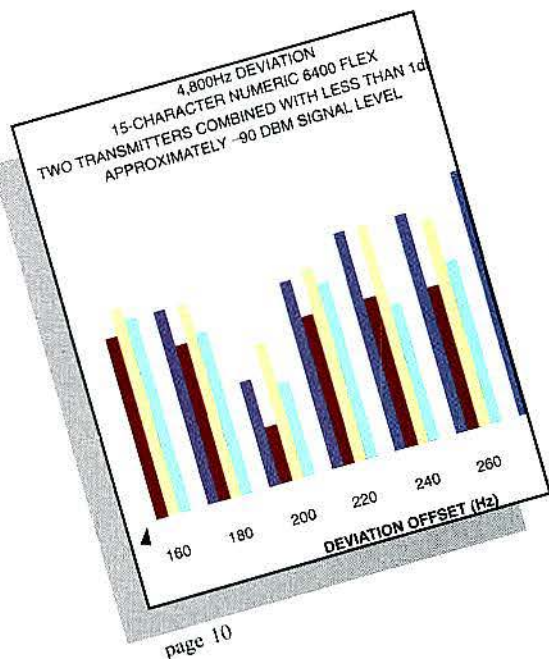
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Mobile Radio Technology (ISSN 0745-7626) is published monthly by Intertec Publishing Corporation, 9800 Metcalf, Overland Park, KS 66212-2215, and mailed free to qualified persons within the United States and Canada. Second-class postage paid at Shawnee Mission, KS, and additional mailing offices. POSTMASTER: Send address change to Mobile Radio Technology, P.O. Box 12960, Overland Park, KS 66282-2960. SUBSCRIPTIONS: Non-qualified persons may subscribe at the following rates: United States and Canada: one-year: \$30.00. Qualified and non-qualified persons in all other countries: one-year: \$40.00 (surface mail); \$105.00 (air mail). Subscription information: P.O. Box 12937, Overland Park, KS, 66282-2937.

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Scanning . . .



Next-generation cellular

To help commemorate the 20th anniversary of the International Wireless Communications Expo (IWCE), Intertec Publishing produced a four-page brochure titled "IWCE Then and Now." Copies were distributed at IWCE. (Mercy Contreras, MRT's group publisher, and Elsa Saavedra, an editor with Intertec, researched and wrote the brochure.)

Some of the research involved reviewing industry news published at the time of the first IWCE, and some of those stories covered plans for the first cellular systems in Washington. The commencement of operations for these systems would come six years later. "Cellular may be successful in Washington," said people who seemed knowledgeable at the time, "but Washington is unique. It's doubtful that it will be as successful anywhere else. Certainly not in markets any smaller than the top 10."

These days, people who seem knowledgeable doubt the success of wideband personal communications services (PCS), another wireless telephone service similar to cellular. Incidentally, consumers have no idea what "wideband PCS" means. We've been waiting to see what wideband PCS will be called in public, and right now "the next-generation cellular" seems to be the label applied to the service.

"The next-generation cellular will cost too much to build to be successful," say people who seem to be knowledgeable. "Cellular operators obtained their licenses for free, but PCS operators have to spend hundreds of millions, even billions of dollars for licenses even before they build. Then, building systems requires more sites and more infrastructure than cellular re-

quires. It may succeed in the largest cities where there is room for more competition, but it can't succeed elsewhere."

Maybe cellular would not have grown to the extent it has if it had remained as it originally was conceived—a car phone service. It changed, and almost every cellphone sold today is a portable.

Maybe the next-generation cellular will not grow to become wildly successful if it becomes only another portable telephone service. Integrated services that include data and voice messaging, built-in keyboards and other computer capabilities in addition to voice telephone service may help the next-generation cellular to compete.

We can see that the critics of wideband PCS have a point. Even so, the success of next-generation cellular may result from its becoming something other than initiators envision as they plan to build systems. How to estimate the risk? It can be calculated in the billions.

* * *

Summer thaw in Washington

While certain segments of the mobile communications industry are obtaining federal licenses to construct facilities and commence operations, other segments continue to be suppressed by moratoriums (freezes) on the issuance of new licenses. The construction and expansion of private radio systems, those systems built by individual companies such as utilities, transportation companies, agribusiness and various commercial enterprises to handle their internal communications, continues to be blocked by freezes. It has been estimated that the purchase of as much as \$100 million to \$200 million of new equipment has been delayed because of the freezes.

Although pleas to lift the private radio freezes have gone unanswered, a similar interruption of commerce and the possibility of layoffs among manufacturers was sufficient reason for Congress to pressure the FCC to partially lift a freeze on paging licenses. On April 23, the FCC partially lifted the freeze that it imposed on Feb. 8 on new paging license applications.

"The partial lifting of the freeze allows paging companies to apply for additional transmitter sites on a primary basis if (1) the applicant is an incumbent on a non-nationwide common carrier paging channel or an incumbent paging licensee that has earned local or regional exclusivity on

a private carrier paging (PCP) channel and (2) the applicant certifies that the proposed site is within 40 miles of an existing (as of Feb. 8) transmitter. Applications that meet these requirements will be placed on public notice and subject to competing applications within the applicable filing window.

"For shared PCP channels, incumbent licensees will have the same opportunity to file applications within 40 miles of an existing site, but will not be subject to competing applications procedures." (Source: PCIA.)

One of the companies most adversely affected by the freeze is Glenayre Technologies, Charlotte, NC. "Glenayre, in partnership with the Coalition for Competitive Paging and other key members of the paging industry, was one of the driving forces behind the FCC's decision," said company president Ray Ardizzone. "Our collective comments and visits to the FCC staff and commissioners, and especially the many meetings and tremendous support from a large bipartisan group of congressional representatives and senators, informed the FCC that the freeze, as imposed, was not in the best interest of the paging operators, manufacturers nor the paging-user industry in general."

The interpretation is that the FCC could not be moved until pressure was applied by Congress. Congress is where the action is when it comes to lifting these kinds of freezes. Maybe the partial lifting of the paging freeze offers an example for private radio.

—Don Bishop

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July

- 11-13—**Communications Expo/Show of the Americas**, Miami, FL. Contact: 305-229-9992.
14-17—**Forestry-Conservation Communications Association** annual conference, Howard Johnson Plaza Hotel, Madison, WI. Contact: Tom Tuttle, 608-246-7998.

August

- 11-15—**International Association of Public-Safety Communications Officials (APCO) National Conference**, San Antonio, TX. Contact: 800-949-2726.

September

- 19-21—**Personal Communications Showcase**, sponsored by the Personal Communications Industry Association, Moscone Convention Center, San Francisco. Contact: 800-326-8638.

October

- 30-Nov. 1—**WirelessWorld Conference and Exposition**, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Orange County Convention/Civic Center, Orlando, FL. Contact: Susan Link, 913-967-1969.

November

- 22—**Radio Club of America, Communications Symposium**, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.
18-19—**AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Intercontinental Hotel, Miami. Contact: 202-331-7773.

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April

- 22-24—**International Wireless Communications Expo**, co-sponsored by *Mobile Radio Technology*, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

May

- 5-7—**Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Hyatt Regency at Civic Plaza, Phoenix, AZ. Contact: Wendy Rochelle, 908-562-3870; Fax 908-981-1769.

June

- 16-20—**UTC National Conference & Exhibition**, sponsored by UTC, The Telecommunications Association, Oregon Convention Center and Red Lion Lloyd, Holiday Inn & Travelodge Hotel, Portland, OR. Contact: 202-872-0030.



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Getting more from your spectrum analyzer

By Harold Kinley, C.E.T.

These days, most land mobile radio shops have at least one spectrum analyzer available. This piece of test equipment has become practically indispensable, considering the level of electromagnetic interference present in the spectrum today. Let's look at some of the methods for enhancing the use of the spectrum analyzer.

Preamplifiers

Preamplifiers can certainly boost the small-signal performance of a spectrum analyzer. However, as with practically any other electronic device, all preamplifiers are not created equal. The preamplifier should be used with a knowledge of how it might affect the overall operation of the spectrum analyzer. Basically, three factors must be considered in choosing the proper preamplifier: gain, noise figure and dynamic range. Let's take a closer look at how these characteristics can affect the overall spectrum analyzer operation.

Let's assume that we have a spectrum analyzer with a noise figure of 30dB. Don't confuse this with noise factor. Noise figure is stated in decibels. Noise factor is stated as a multiplication factor. To convert noise factor to noise figure, use the following formula:

$$\text{Noise factor} = 10^{(\text{noise figure}/10)}$$

For example, to convert a noise figure of 6dB to a noise factor, the calculator keystrokes are

$$6 \div 10 = \lnv \log$$

which yields 3.981071705.

Suppose we have a spectrum analyzer with a noise figure of 30dB (not unusual) and a third-order intercept point (Ip_3) of +10dBm. Let's look at how different preamplifiers might affect the overall operation. Figure 1 above shows the setup for the spectrum analyzer and preamplifier.

Assume that the preamplifier has a gain of 20dB, a noise figure of 6dB and an Ip_3 of +15dBm. There are several things we would like to know about the new setup. What is the new noise factor? What is the new (small-signal) signal-to-noise ratio? How is the dynamic range affected in terms of the third-order intercept point (Ip_3)?

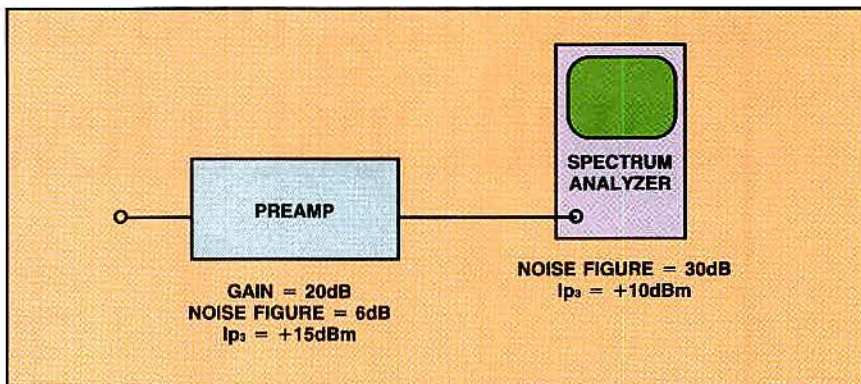


Figure 1. Using a preamplifier ahead of a spectrum analyzer can improve the small signal performance greatly. However, beware of reductions in overall dynamic range. The maximum input to the preamp should be limited to the maximum input to the spectrum analyzer, minus the gain of the amplifier.

Generally speaking, the maximum input to the preamplifier should be limited to the maximum input rating of the spectrum analyzer, minus the gain of the preamplifier. So, what is the overall noise figure of the preamplifier/spectrum analyzer combination? To determine this, we use the formula for noise factor for cascaded devices and then convert the noise factor to noise figure in decibels. The formula for noise factor of cascaded devices is:

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}$$

where

F = noise factor

F_1 = noise factor of first device in cascade

F_2 = noise factor of second device

G_1 = gain of first device

G_2 = gain of second device.

The overall noise factor (F) for the spectrum analyzer and preamplifier shown in Figure 1 is:

$$F = 4 + \frac{1000 - 1}{100} = 4 + \frac{999}{100} \\ = 4 + 9.99 = 13.99$$

This translates into a noise figure of

$$10 \log (13.99) = 11.5 \text{ dB.}$$

Since the noise figure of the spectrum analyzer alone was 30dB, this represents a noise figure improvement of 30dB - 11.5dB, or 18.5dB, with the preamplifier connected.

What happens to the third-order intercept point (Ip_3)? Table 1 at the left shows the correlation between the preamplifier Ip_3 and the reduction in overall Ip_3 . These figures represent the preamplifier Ip_3 minus the spectrum analyzer Ip_3 . These figures represent a worst-case scenario, where the intermod signals combine in phase to produce maximum level intermod.

(continued on page 42)

Table 1. Correlation between the preamplifier Ip_3 and the reduction in the overall Ip_3 .

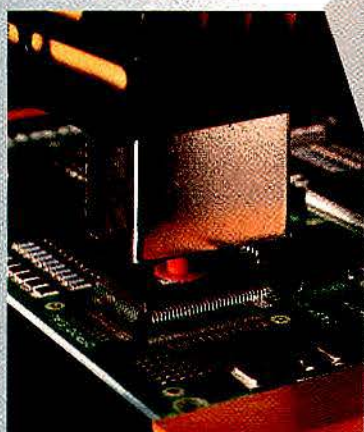
PREAMPLIFIER Ip_3 MINUS ANALYZER Ip_3	DEGRADATION OF OVERALL Ip_3
0dB	-6.0dB
3dB	-4.6dB
6dB	-3.5dB
10dB	-2.4dB
15dB	-1.4dB
20dB	-0.8dB
25dB	-0.5dB
30dB	-0.3dB

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewyld Drive, Spartanburg, SC 29301.

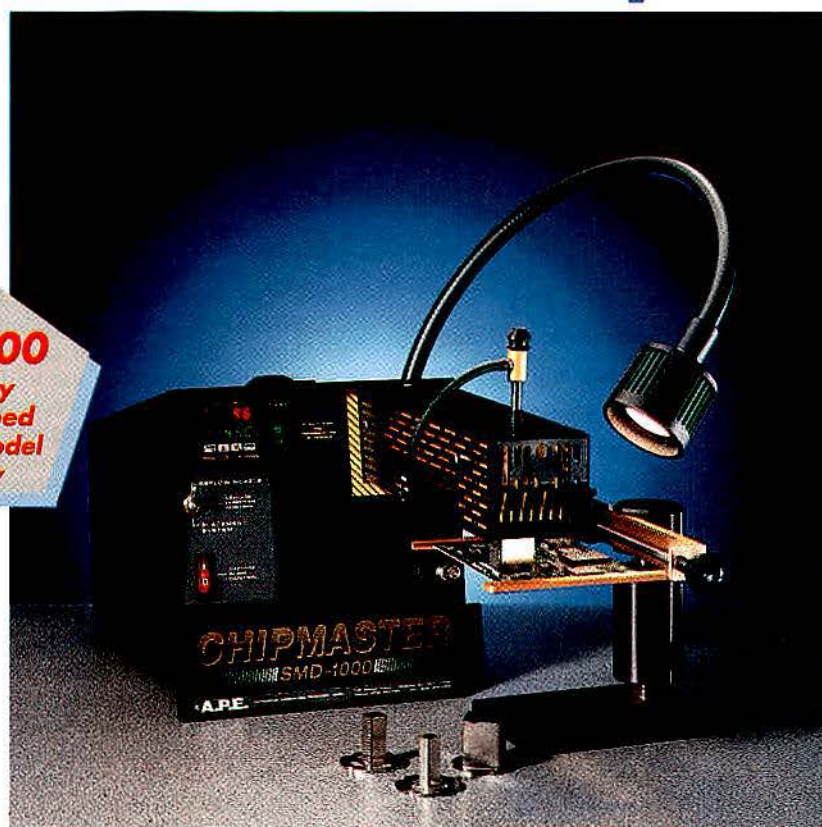
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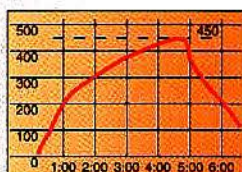


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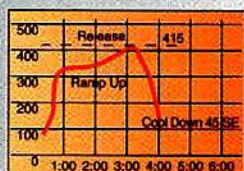


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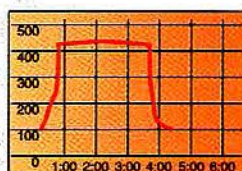
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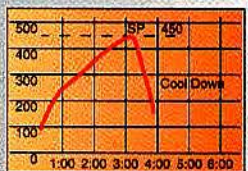
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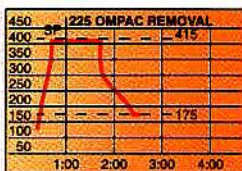
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System integration of the Flex paging protocol

Part 1—System design constraints.

Integration of the Flex paging protocol onto existing paging channels will present system design challenges for systems not yet optimized for the higher data rate of 6,400 bits-per-second (bps), but which are slated for operation at that rate. The most significant constraint facing designers is control of coverage overlap areas. However, until such time that the system may be optimized for 6,400bps, carriers will enjoy several benefits in paging with 3200 4-level Flex over 2400 POCSAG. In many cases, there is good reason to introduce the Flex paging protocol, at the operator's earliest convenience, onto paging channels currently performing, even marginally, at 2400 POCSAG.

By Lee I. Williams

The Flex paging protocol holds the promise of greater error immunity and higher data rates than any other paging encoding protocol in use to date. Greater error immunity is accomplished by using Bose-Chadhuri-Hocquenghem (BCH) coding along with an interleaving process that helps to minimize burst-type errors that often are prevalent in a radio frequency (RF) environment. Increased data rates are accomplished by the modulation technique of 4-level frequency-shift keying (FSK). However, these potential increases come at a price. Greater error immunity requires greater overhead in terms of pre- and post-transmission processing, and increased data rates significantly challenge simulcast system designs in terms of overlap area control. The following information points out prominent design constraints facing Flex integration and offers suggestions for optimizing system performance.

Simulcast delay spread

In most paging systems, the biggest challenge facing acceptable 6400 Flex performance is management of simulcast delay spread (SDS) to acceptable levels. (In a multitransmitter simulcast system, SDS error always occurs. The challenge is to optimize the system's design parameters to keep error within a specified margin.) SDS is often referred to as *simulcast error* or *simulcast misalignment*; however, the term *delay spread* will be used instead because it is more familiar to those with cellular experience, and it is a more de-

scriptive term of the phenomenon.

SDS, for our purposes, is a received misalignment of state transitions caused by signal timing differences in a multitransmitter simulcast system. Stated more simply, the RF signals from two or more transmitters reach the receiver at different times and with relatively equal energy, causing distortion at the transition edges. (The effect of SDS is a function of both the time and energy level differences of the signals available to the receiver. Available signals within a 6dB differential generally are assumed to be close enough in magnitude to have a significant effect on the receiver. When two or more signals are present with levels close enough to affect the receiver, the situation often is referred to as *non-capture*.) The two causes of this type of delay spread are:

1. The information signal actually leaves individual transmitters at different times. (Implicit in this statement is the concept of bit jitter, which is a consequence of processor speed and part tolerances. Using current technology and good design practices, bit jitter may be held to insignificant amounts.)

2. The propagation paths from the various transmitters to the receiver, differ in length.

The first cause of SDS may be compensated for by proper configuration techniques such as introduced delay for equalization or by synchronization to the National Institute of Standards and Technology's Universal Coordinated Time (UTC) via the Global Positioning System (GPS). However, the second cause of SDS, a difference in propagation path distances, ultimately is a parameter that must be

Table 1—Paging format and associated one-fourth symbol width.

Paging Format	One-fourth Symbol Width (μ s)
POCSAG 2400	104
3,200 2-level Flex	78
3,200 4-level Flex	156
6,400 4-level Flex	78

Williams is senior systems engineer at Glenayre Electronics, Quincy, IL.

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dealt with in terms of system design and propagation analysis.

SDS in the time domain

SDS is noticeable in the time domain by demodulating the RF signal and displaying the waveform with an oscilloscope. Figure 1 on page 14 shows a digital storage oscilloscope (DSO) capture of a demodulated FSK waveform showing SDS. Note that the FSK transition edge is dis-

torted by approximately 150 to 180 microseconds of timing error.

The general rule of thumb for allowable SDS is one-fourth of the symbol width. On that basis, the acceptable error for POCSAG 2400, 3200 2-level Flex, 3200 4-level Flex and 6400 4-level Flex are shown in Table 1 on page 10.

Note that going from a 2-level FSK to a 4-level FSK modulation scheme, for a given data rate, doubles the symbol width

of the transmitted signal and, consequently, the allowable SDS. The symbol width for 4-level modulation is doubled because two data bits are encoded into each symbol instead of one bit encoded per symbol in 2-Level modulation.

Figure 2 on page 14 shows a demodulated DSO capture of 3200 4-level Flex, POCSAG 2400 and 6400 4-level Flex. Note the difference in symbol width between the various formats. In particular, the symbol width of 3200 4-level Flex is 30% greater than that of POCSAG 2400 and, therefore, more tolerant of SDS.

SDS in the spatial domain

It is often preferable to convert SDS to the spatial domain when analyzing system performance. This is easily accomplished by dividing by the velocity of light. (Electromagnetic waves travel through free space at the speed of light, about 5.4 microseconds per mile.) The allowable SDS amounts (i.e., one-fourth of the symbol width), converted to a distance, for POCSAG 2400, 3200 2-level Flex, 3200 4-level Flex and 6400 4-level Flex have been calculated below:

$$\text{POCSAG 2400: } 104\mu\text{s} \times \frac{1\text{mi}}{5.4\mu\text{s}} \cong 19.3\text{mi}$$

$$3200 \text{ 4-L Flex: } 156\mu\text{s} \times \frac{1\text{mi}}{5.4\mu\text{s}} \cong 28.9\text{mi}$$

$$3200 \text{ 2-L and 6400 Flex:}$$

$$78\mu\text{s} \times \frac{1\text{mi}}{5.4\mu\text{s}} \cong 14.4\text{mi}$$

(Both 3200 2-level and 6400 Flex have the same symbol width and, therefore, the same SDS constraints.)

In terms of distance, 3200 4-level Flex is more tolerant of SDS by a 9.6-mile margin over POCSAG 2400, and POCSAG 2400 is more tolerant of SDS by a 4.9-mile margin over either 6400 Flex or 3200 2-level Flex.

A simplistic two-dimensional, two-transmitter overlap zone is shown in Figure 3 on page 16. Let us presume that the convergence region between two transmitters, located at TX-A and TX-B is a non-capture area of maximum width δ , according to the one-fourth of the symbol width constraint, is about 28.9 miles for 3200 4-level Flex, 19.3 miles for POCSAG 2400 and 14.4 miles for 6400 Flex.

This tightening of the SDS constraint for 6400 Flex may not seem too radical at this point; however, the example given is far too simplistic to adequately characterize the situation encountered in an actual paging system. First of all, real-world antennas are not isotropic, and their propagation characteristics in a simulcast system

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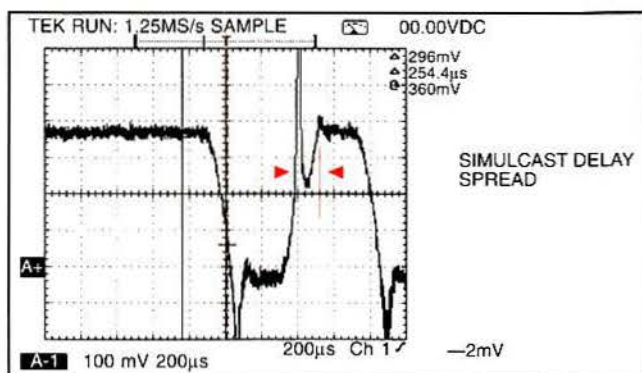


Figure 1. Oscilloscope trace of POCSAG 2400 data transmission showing simulcast delay spread.

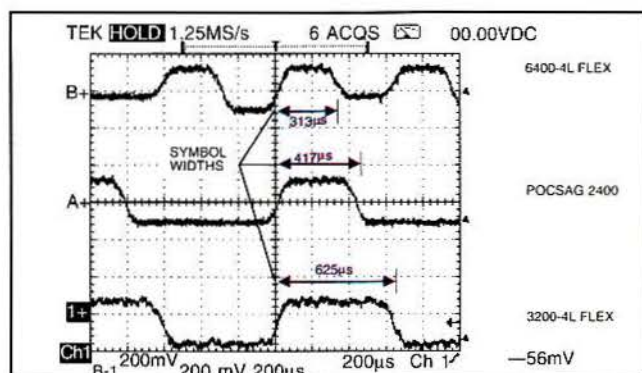


Figure 2. Oscilloscope traces of 6400 4-level Flex, POCSAG 2400 and 3200 4-level Flex, showing differences in symbol width.

are highly dependent upon type, gain, relative elevation and orientation. (Isotropic propagation presumes a spherical radiation pattern, equal in magnitude for any propagation path of the same radius from the antenna element.) In addition, the phenomena of reflection, diffraction and scattering need to be taken into account. The topographical environment, both natural and manmade, has a significant effect upon the received signal level.

Figure 4 on page 16 is a more realistic view of a two-dimensional, two-transmit-

ter overlap region. Note that localized pockets of non-capture may occur at random throughout the coverage area because of any number of the reasons previously mentioned. Of particular importance, Figure 4 dismisses any myths that Figure 3 is representative of an actual simulcast paging environment. In Figure 4, X represents a pager location that happens to be in one of a number of non-capture overlap areas created by transmitters TX-A and TX-B, and δ represents the SDS between the two transmitters. To calculate the propagation

path difference, δ , a circle of radius r , centered at X and passing through the nearest transmitter location, TX-B, is drawn. On a straight line from the receiver location, X, to TX-A, the δ of concern is the line segment from the point of intersection with the circle to the location of TX-A.

Figure 4, in addition, points out good reason for placing transmitter sites within the SDS constraint of adjacent transmission sites (e.g., 14.4 miles for 6400 Flex). That is, if TX-A and TX-B are not

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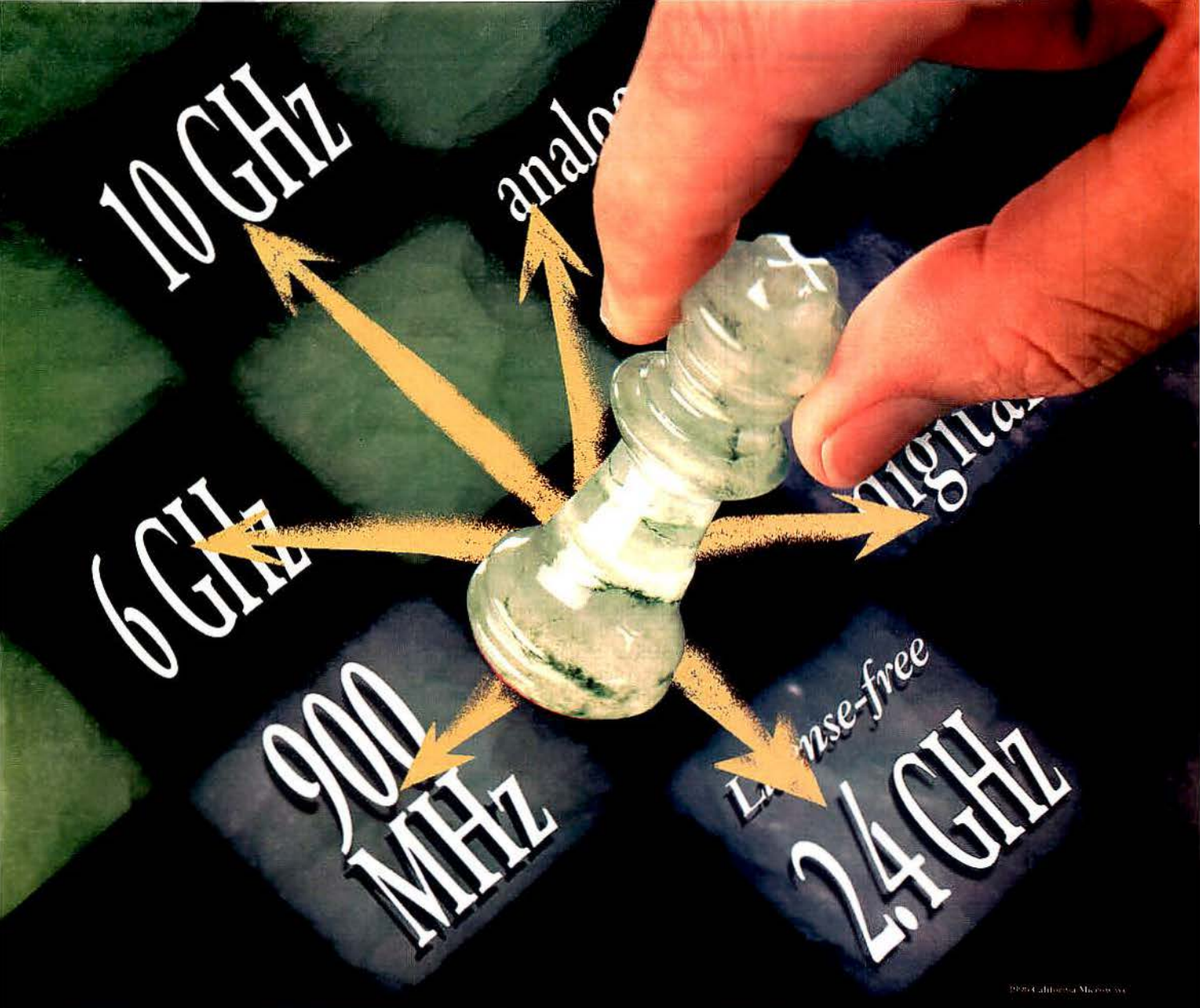
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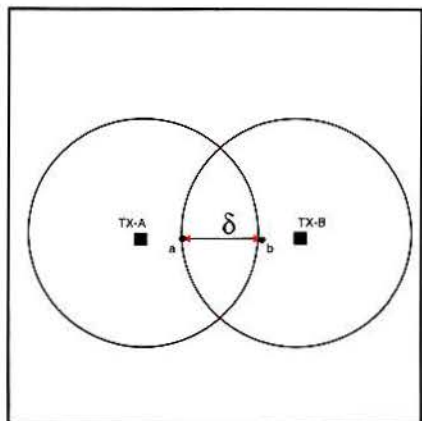


Figure 3. A simplistic view of a two-transmitter overlap.

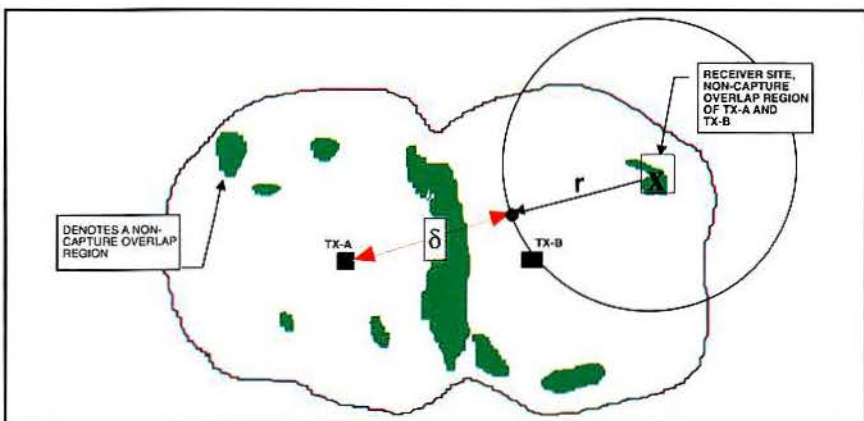


Figure 4. A more realistic two-transmitter overlap showing non-capture areas.

separated by more than the spatial SDS constraint, then there will be no receiver non-capture location at which the SDS constraint will be exceeded by those two transmitters. However, in simulcast system design, care must be exercised to ensure that signals from sites farther away than the adjacent sites do not propagate into the coverage area with sufficient signal strength to cause SDS problems. A situation which is often encountered in the

field occurs when the receiver is RF-shaded from a nearby transmitter site, by a structure, the local terrain or both, reducing the received signal strength enough to allow SDS to be introduced by a more distant transmitter. Furthermore, the receiver is likely to be in an overlap region of more than two transmitters. When disruptive SDS is present, it is often found that there are several distant sites contributing to the SDS in a cumulative manner.

The effects of SDS are not limited to areas of low received signal strength. In fact, this condition is often present in areas with more than adequate signal level (e.g., -70 dBm). In general, the problem is one of too much signal level present from distant sites, and the solution resides in compressing and controlling the propagation pattern to avoid exceeding the SDS constraint. This does not mean that reducing transmitter power is the answer. In

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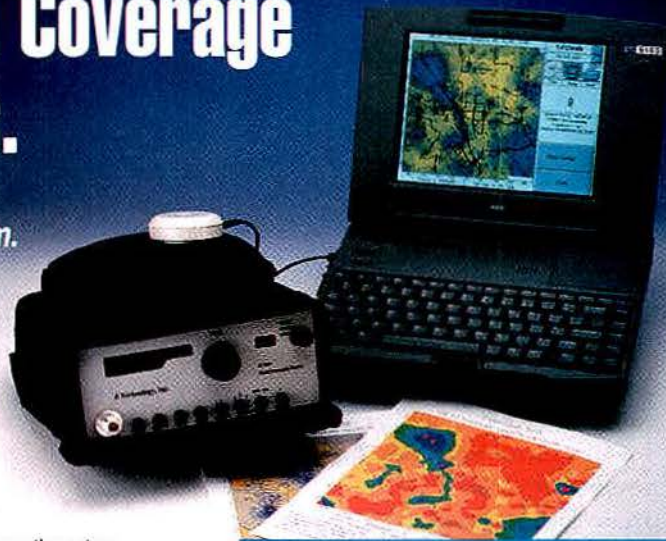
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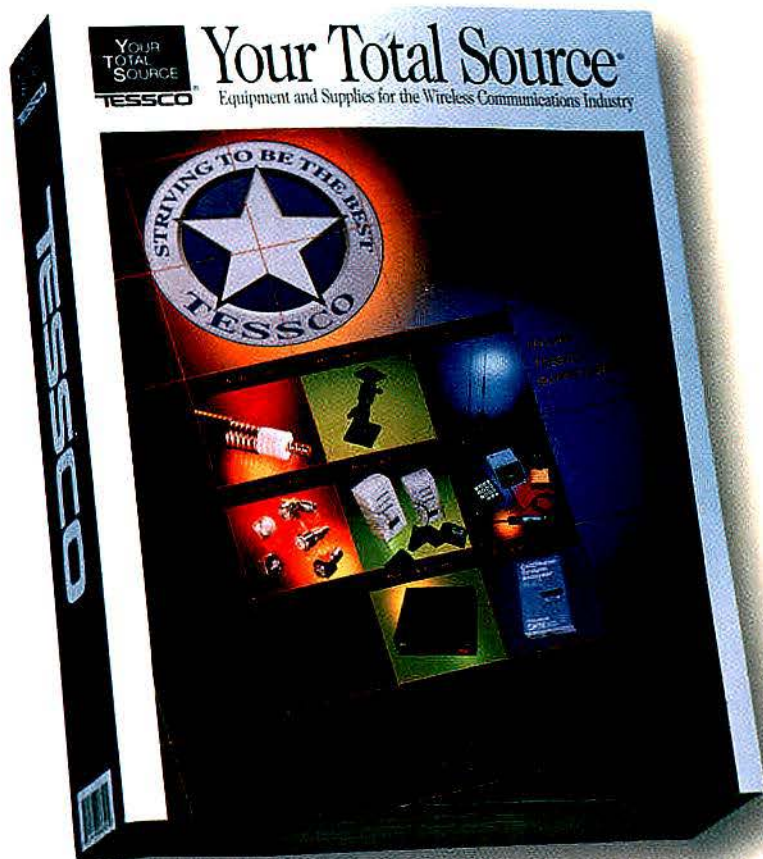
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fact, 6400 Flex requires an additional signal-to-noise margin of about 3dB over 3200 4-level Flex to maintain a desired bit error rate. The key to overcoming SDS problems, by compressing and controlling signal levels, is in the selection of antenna types and gains, transmitting antenna elevations, transmitter output power levels and transmitter site placement. In short, adequate 6400 Flex performance requires proper system propagation analysis and

design. Unfortunately, most current paging systems have evolved from a slower data rate design without proper redesign for the increased data rates. In many cases, the increased signal-to-noise requirements were met by the method of replacing existing antennas with ones of higher gain. (For each doubling of the data rate, the link margin requirement increases by 3dB to maintain a given bit error rate.)

Referring again to Figure 3, the propa-

gation pattern is shown in the horizontal plane only. The problem encountered with higher gain antennas is that the gain increase is accomplished by a narrowing of the vertical beamwidth pattern. This narrowing of the beamwidth directs the signal strength toward the horizon at the cost of reducing it near the transmitter sites. This is precisely the type of situation which promotes SDS problems.

Because SDS is a function of multiple parameters, there is no single design remedy that covers all situations. The simplest design case is that of flat terrain in a rural environment, and the complexity of the design solution increases greatly as the terrain conditions change and as the environment becomes primarily urban. However, there are several design guidelines

Because SDS is a function of multiple parameters, there is no single design remedy that covers all situations.

outlined in part 2 of this article that are pertinent, in general, to providing 6400 Flex. Also outlined in part 2 are some straight-forward diagnostic tools for determining whether or not SDS is problematic in a given area and, in instances, for determining the distant, offending sites.

Zero-beating and deviation offsets

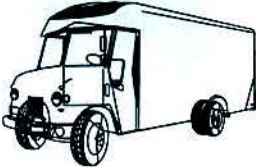
Zero-beating, which is actually a phase cancellation condition, is presumed to occur in an RF simulcast environment periodic at the rate of $1/f_o$, where $1/f_o$ is the total frequency difference between canceling signals. The cancellations occur with less frequency but for longer duration as f_o becomes smaller. Deviation offsets are often used in an attempt to alleviate, or more precisely, to *manage* the phenomenon of phase cancellation. By programming a different deviation offset into the transmitters, a cancellation occurrence can be controlled and the negative effects minimized. (A deviation offset increases or decreases the actual deviation level by the offset amount. For example, a +10Hz offset programmed into an exciter set to deviate at $\pm 4,500\text{Hz}$ would result in actual deviation levels of $-4,490\text{Hz}$ and $+4,510\text{Hz}$.)

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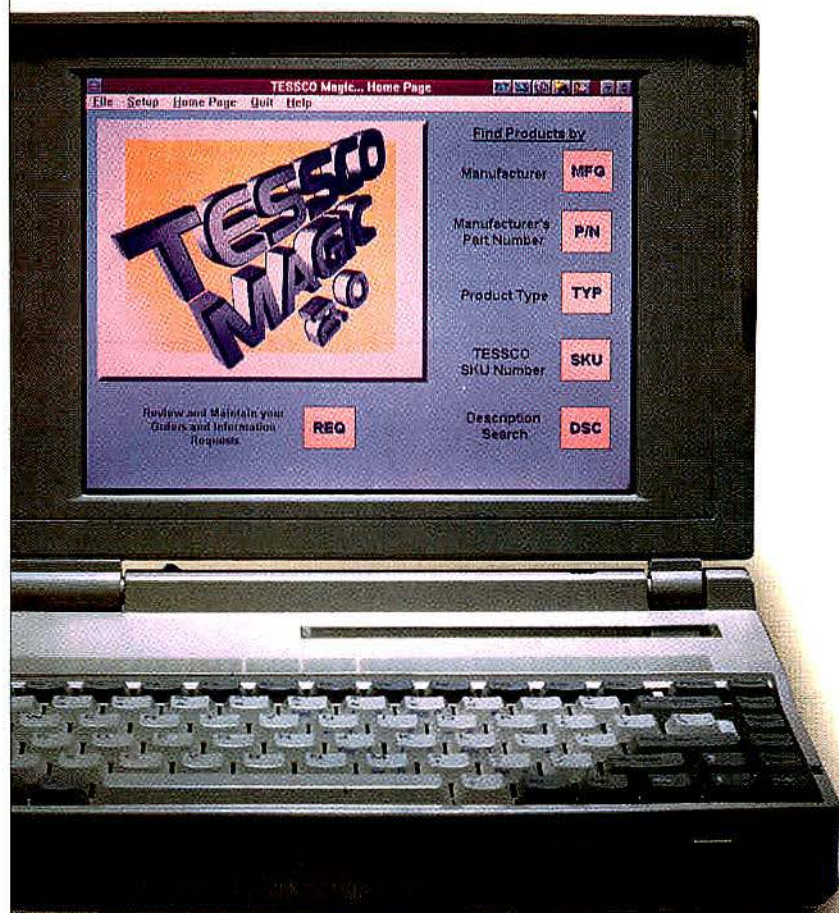
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Table 2—Deviation offset, cancellation occurrence and frequency of bit collision for Flex.

Deviation Offset (Hz)	Occurrence of Cancellation (ms)	Possible Bit Collision of Pager Word
200	5	every bit
100	10	every other bit
50	20	every fourth bit
40	25	every fifth bit
25	40	every eighth bit

Difficult to observe in the field, zero-beating is most likely to occur in weak overlap regions of only two transmitters because the probability of phase cancellation is greatly reduced as more signals are added and/or as the carrier-to-interference margin increases. In addition, because of the increased accuracy and stability of later-generation exciters, zero-beating has become an issue of greater concern than it was with older, less-accurate equipment.

According to laboratory results in a stationary environment at low signal levels, POCSAG performance shows the most improvement with relatively large offsets (i.e., 200Hz to 1000Hz), whereas 6400 Flex shows optimum improvement with smaller offsets (i.e., less than 200Hz). Initial laboratory testing of 6400 Flex offsets points to multiples of 30Hz as producing the best results (e.g., 30Hz, 60Hz, 90Hz and 120Hz) with multiples and sub-multiples of 200Hz producing less desirable

results. The reason for the reduced performance relates to the data rate and block structure of 6400 Flex. Using a 32-bit-by-32-bit block structure along with an interleaving process results in a bit of information associated with a particular pager being transmitted every 5 milliseconds at a rate of 200Hz. Table 2 at the left shows the relationship among deviation offset, cancellation occurrence and the frequency of a possible bit collision with a phase cancellation in a particular pager's information word.

The implication is that certain offsets exist that produce degradation because of their timing alignment with the block structure, and the results of a two-transmitter overlap simulation show a correspondence to that notion.

Figure 5 and Figure 6 on page 22 are graphs of data taken with a two-transmitter overlap in a static, low-signal-strength environment with various offsets introduced. *The data taken in this experiment are presented only with the intent to show trends related to various offset schemes and should not be considered absolute.* (Jack Gleeson, engineering manager at Motorola Subscriber Development

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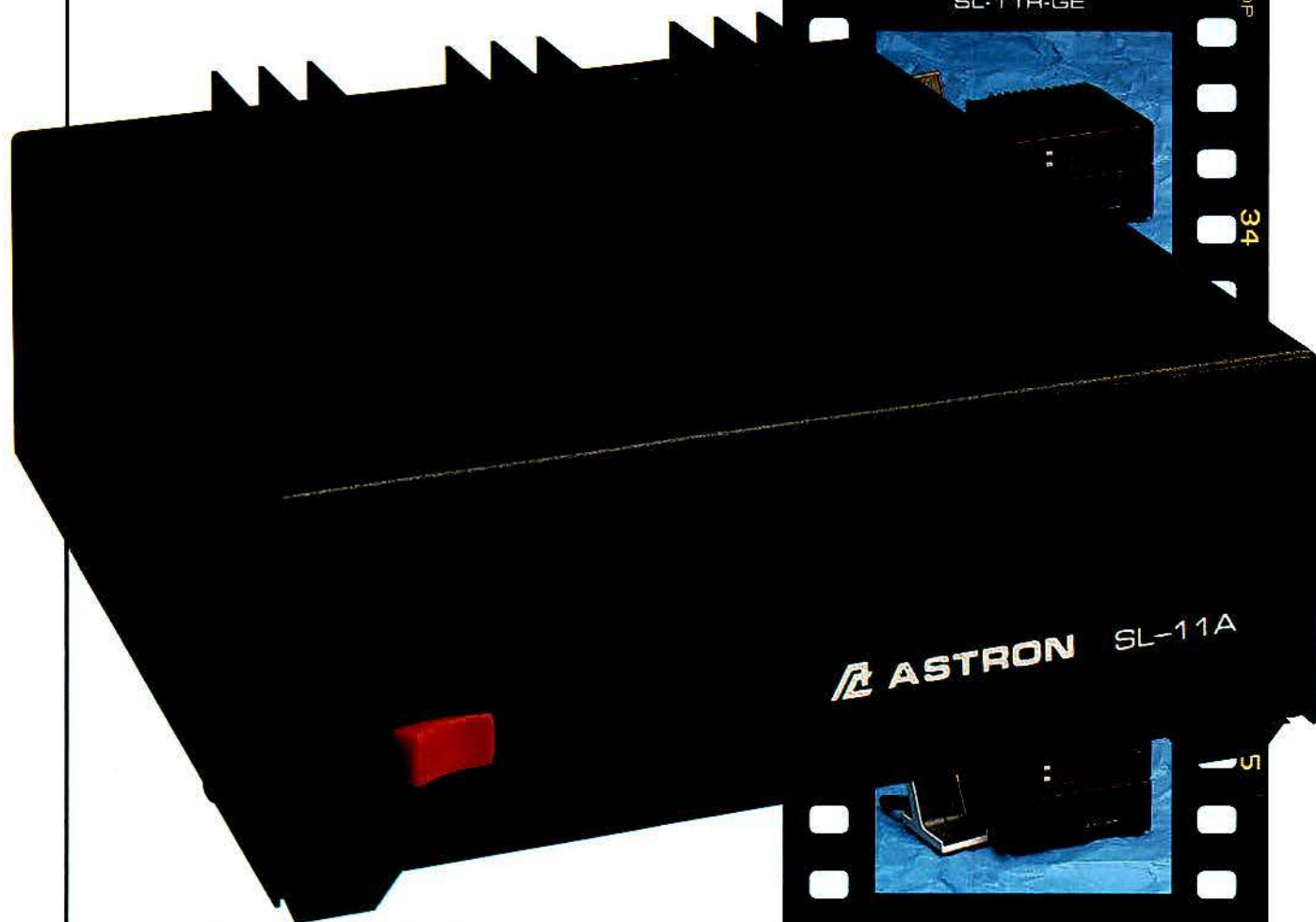
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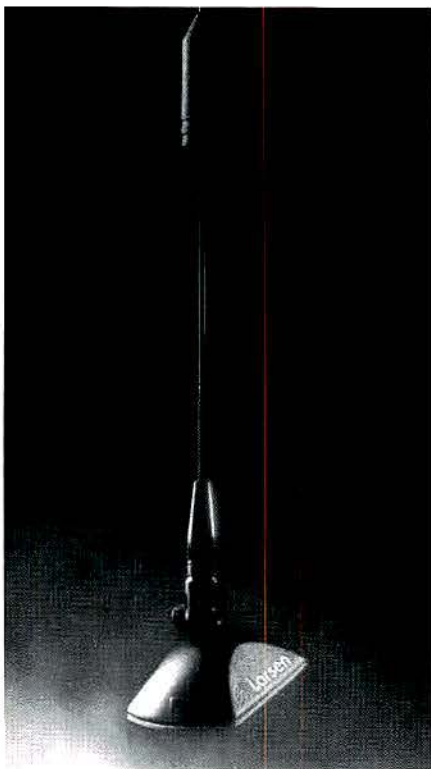
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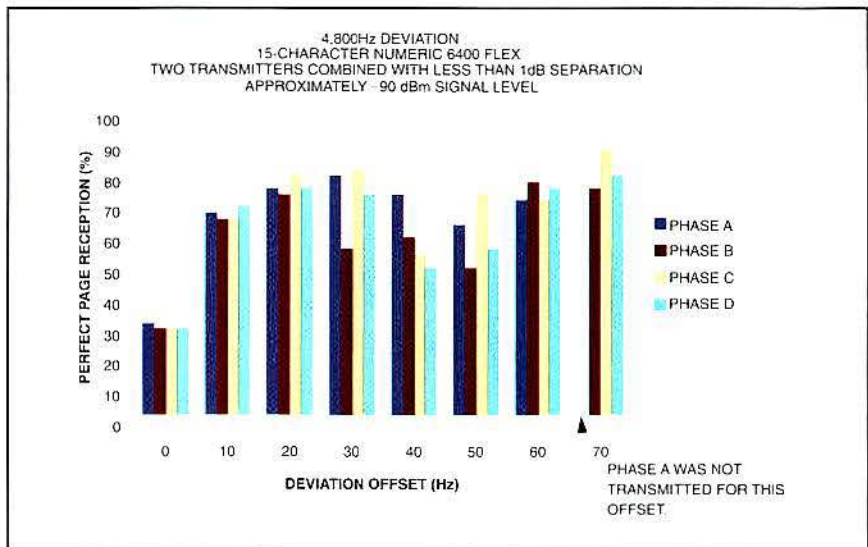


Figure 5. Perfect page reception vs. deviation offsets of 0Hz to 70Hz.

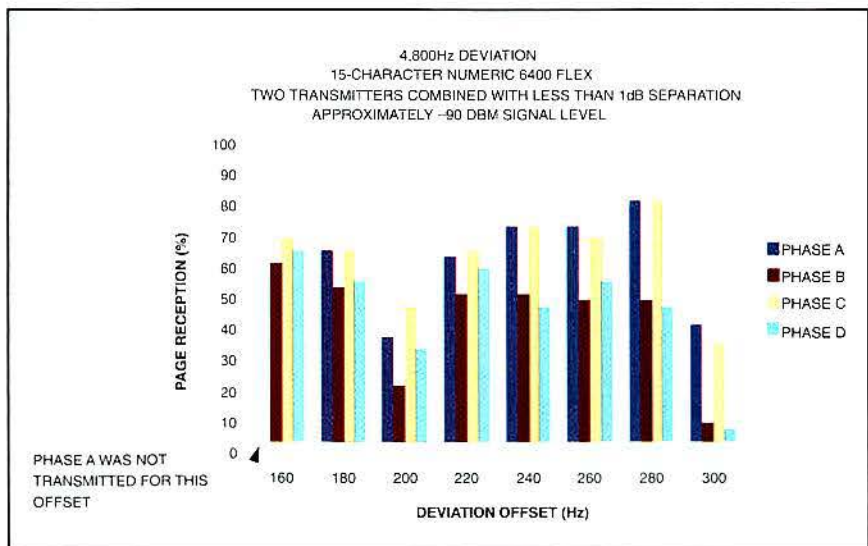


Figure 6. Perfect page reception vs. deviation offsets of 160Hz to 300Hz.

Engineering, has been involved with extensive studies of deviation offset schemes and their effects upon paging probability in various simulated RF environments. The data presented here show correlation to the static environment findings at Motorola.) Actual performance is a function of many variables, including signal strength, fade distribution and the receiver's demodulation technique. The results presented in Figures 5 and 6 are based upon tests run with 50 pages sent to a ProEncore pager on each of the four Flex phases (i.e., phases A, B, C and D). Test pages were encoded with a Glenayre GL3000-ES paging terminal and transmitted via two Glenayre GL-C2000 transmitter controllers and two Glenayre Gold Series excitors. Decoding was accomplished with

an Advanced Signal SignalPro data and signal analysis tool. Transmitted pages were 15-character numeric, and the graphed results are a percentage of received perfect pages.

Figure 5 shows minimum paging reception at the 0Hz deviation offset setting, with slightly reduced performance at the 40Hz and 50Hz settings. Phase A and phase C performance appeared to be comparable to phase B and phase D with small deviation offsets.

Paging reception minimums are seen at 200Hz and 300Hz in Figure 6. Also, it is apparent from Figure 6 that phase-B and phase-D paging probability drops more rapidly than that of phase A and phase C as deviation offsets are increased. Therefore, large POCSAG-type offsets should

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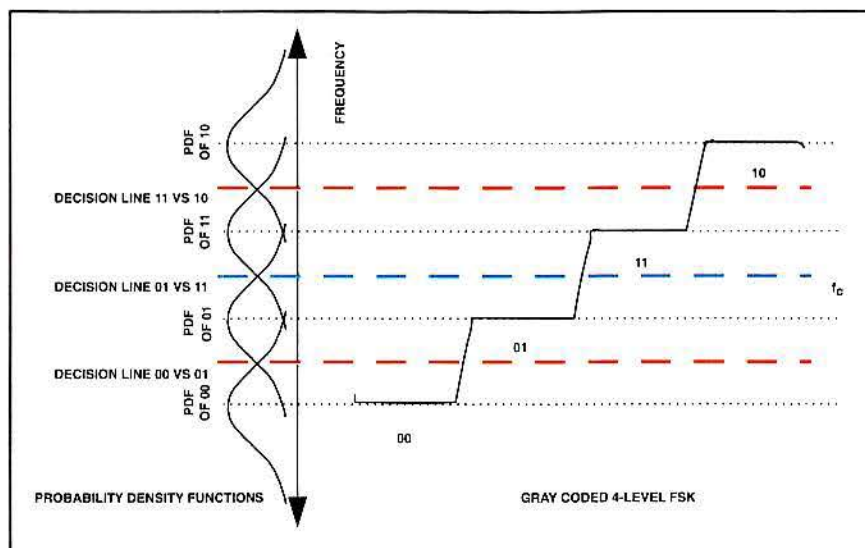


Figure 7. Probability density functions and Gray-coded frequency-shift keying levels (the discriminator demodulation).

be avoided for 4-level Flex.

Presuming that the pager uses a discriminator demodulation technique, a possible reason for this condition may be explained by considering the probability density functions (PDF) of the symbol FSK states (or

levels) and the way the pager information is encoded into each state. Figure 7 above shows a PDF for each of the four FSK levels at the discriminator output.

For the purpose of example, a normal distribution has been assumed for each

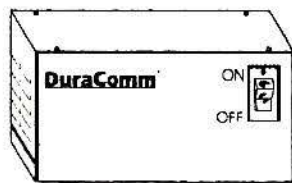
PDF. Decision lines are shown at the point of intersection between adjacent PDFs which simply identify that there are three regions of overlap for which a decision may need to be made as to which FSK symbol has been received.

Because of the interleaving process and block structure of 6400 Flex, phase-A and phase-B bits are grouped together, and phase-C and phase-D bits are grouped together in two bit pairs. Phase-A and phase-C bits are always the most significant bits and phase-B and phase-D bits are always the least significant bits of the two-bit pairs.

Referring to Figure 7, note that of the three regions of overlap where the decision lines are shown, the regions between 00 and 01 and between 11 and 10 (denoted with red dashed decision lines) are dependent only upon the least significant bit. That is, for example, a 00 symbol could be incorrectly decoded as a 01 symbol, yet, since the most significant bit is the same for either symbol, only the least significant bit would be in error. The region between 01 and 11 (denoted with a blue dashed decision line) is dependent only upon the most significant bit. Thus, it

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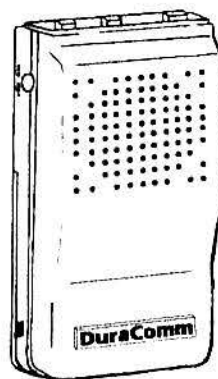
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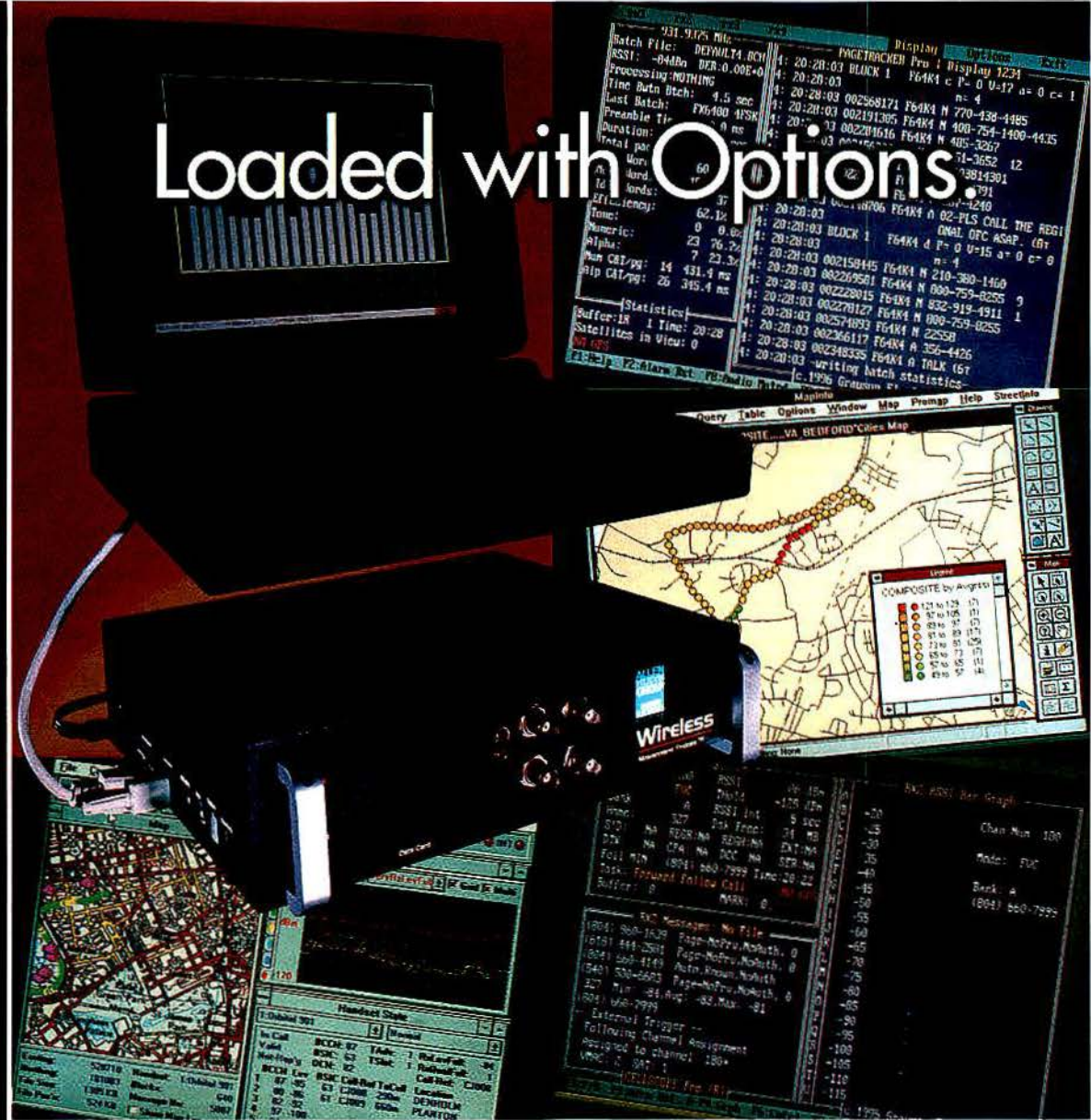
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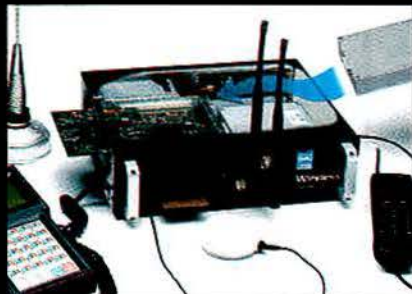


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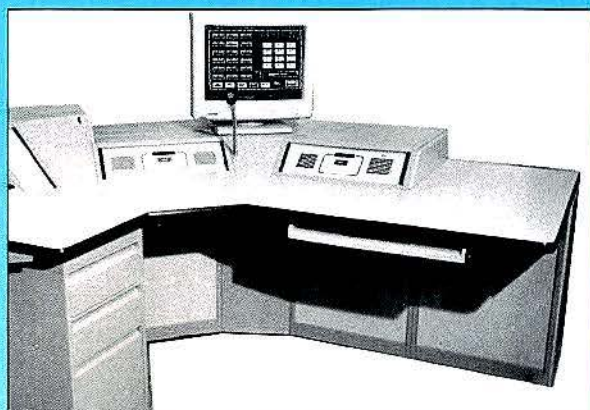
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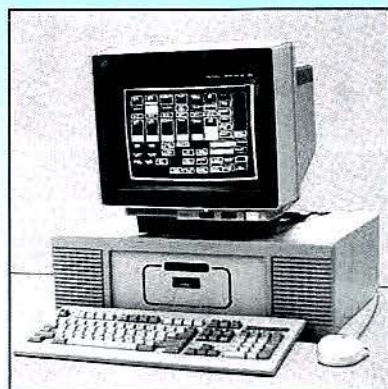
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would appear that the phase-B and phase-D pagers have a greater likelihood of bit errors than the phase-A and phase-C pagers because there are two decision areas which affect the least significant bit and only one decision area that affects the most significant bit. Thus, as the deviation offsets get larger and the actual deviation level shifts closer to the decision line region, the performance of the phase-B and phase-D pagers fall off more rapidly.

Deviation: POCSAG vs. Flex

POCSAG pagers are optimized for 4,500Hz deviation, and Flex pagers are

*POCSAG pagers are
optimized for 4,500Hz
deviation, and Flex
pagers are optimized for
4,800Hz.*

optimized for 4,800Hz. Thus, the question arises as to which deviation setting should be used on a system that is incapable of adjusting deviation automatically on a protocol basis. Deviating at a different value than prescribed changes the modulation index of the signal, which in turn affects the bit energy-to-noise spectral density (E_b/N_0) requirements of the receiver. To know the true effects of a certain deviation setting on a particular pager, one must know the demodulation technique used for that pager (e.g., matched filter or discriminator.). According to both NEC America and Motorola, Flex pagers should show no significant sensitivity loss with a signal deviation of 4,500Hz reduced from the optimum 4,800Hz. Nevertheless, the ability to change deviation on a protocol basis allows the system to be optimized for both POCSAG and Flex and should be an infrastructure provider's design goal for the near term.

Part 2, which concludes the series, covers system design recommendations.

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Circle (23) on Fast Fact Card

Installing radios in vacuum cleaners

Mounting communication systems in vac trucks and fuel trucks poses some unique problems. Make careful plans, check with the operator and check with other experts such as fire officials to ensure a successful installation.



Photo 1. The vac truck is used for a variety of tasks, even in remote areas.



Photo 2. A short boom protects the roof of the cab—and maybe the antenna.

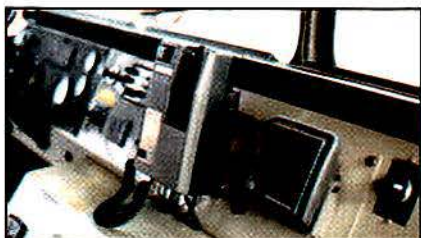


Photo 3. The fuel truck has a huge, uncluttered dash, which is fine for mounting radio equipment.



Photo 4. Glass-mount antennas are a good choice for fuel trucks.

By Donald E. Koehler

Radio technicians have the opportunity to install radio equipment in unusual vehicles from time to time. This month, the subject is vacuum (vac) trucks and fuel trucks. These trucks offer a similar yet slightly different set of problems to the installer. Both types of vehicles have large hydraulic systems and either a separate power source or an engine-driven (PTO) pump system.

HAZMAT vac truck

The vac truck shown in Photo 1 to the left is used for a variety of functions. A large metal container, either cubic or cylindrical, is mounted on the rear of the truck and is actually a kind of giant vacuum cleaner "bag." Under this container are one or more water tanks feeding into an engine-driven pump and then on to a reeled outlet hose on the front of the vehicle. An engine-driven fan draws air from the container, reducing its air pressure to a level well below ambient (outside) air pressure. The inlet to this container usually has a reinforced hose set, which is used to vacuum up water, gravel, debris or other liquids and solids as desired. Certain nonexplosive petroleum products, such as oil from oil-water separators in urban drain systems, can be removed by this vac truck.

► *Radio installation problems* — The basis of the vac system is a large, commercial, heavy-duty truck. Once the large container and water tank(s) are fitted to the truck, an extensive hydraulic control system is put in. The large, hinged, collection container can be raised at one end to dump recovered material. The tanks, hydraulic controls and movable container pose distinct challenges to the radio installer. Antenna, receive-and-transmit (R/T) unit mounts and power cable routing require planning. Mounting antennas on the collection container, in almost all

cases, is ruled out. Fortunately, most vac trucks have exterior battery boxes, so access to power is generally easy.

The first step, after some basic planning, is to mount the R/T unit and control head firmly in place. Use care to avoid hydraulic control lines and levers in the cab. Check, or have the operator check, all of the controls to be sure that they operate normally before you proceed. The back of the operator's cab and the floor to the rear of the cab are full of control lines, so using a dash mount or an aftermarket pedestal floor mount may be a good choice. Mounting the speaker so it will be near the operator's head when the operator is seated in the cab will help the operator to hear the radio over the noise inherent in these vehicles. Good positions are on the cab's ceiling or above the door. An audio amplifier and an external speaker may be part of the install package. Take care that the speaker will not be exposed to too much engine compartment heat if you mount the speaker driver on the fender.

Once the R/T units are in place, power cabling is next. The battery systems are generally simple, with separate batteries for the main (road drive) and the hydraulic and vacuum drive motor. Once the cables are in place and protected from damage, insert a low-voltage cutout or magnetic switch to protect the battery from being drained and to protect the radio from transient voltages generated by the engine starter motor. Use grommets or other chafe buffers to protect wiring where it passes through the wall of the operator cab or near moving elements of the hydraulic system. Always take a moment to check the voltage of the battery you choose to use as a power source for the radio, because the hydraulic and vacuum drive system engine's charging subsystem may not have as much voltage regulation as the truck battery. In any case, fuse both the

Koehler is the owner of Communication Specialties, Anchorage, AK.



Photo 5. The vac truck battery access is both open and easy to work around. Be sure that the wiring is protected from damage.



Photo 6. The inlet hose and heavy metal support can destroy an antenna that is not carefully installed.

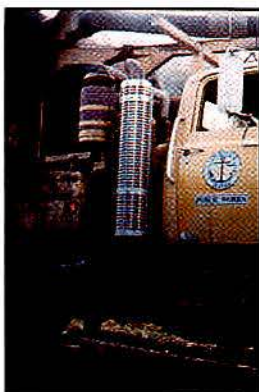


Photo 7. A second engine powers both the fan and water pump subsystems. Be sure that you do not choose the 'wrong' battery to power the radio.

positive and negative lines as close to the battery as possible. Mark the vehicle maintenance records to show battery connections, cable routes and the locations and values of fuses.

Antennas mounted on the roofs of these vehicles face short, tough lives. The collection hose assembly is routed over the top of the operator's cab, so any antenna

mounted there would be struck repeatedly by a large, heavy hose and metal support structures. A short "gallows boom" is built across the cab roof, but is short in relation to the size of the average antenna. (See Photo 2 on page 28.) If there is no suitable place for a whip antenna on the roof, a directional discontinuity ring radiator antenna made by Com-Rad Industries, Wil-

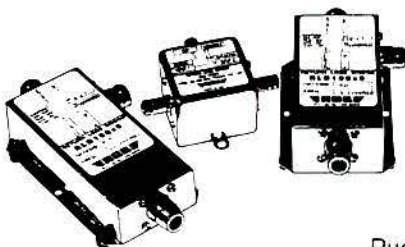
son, NY, could be a good choice. A glass-mount antenna or even a ball-mount on the side of the cab are worth considering for a protected antenna system. The hood of the vehicle may be the last antenna mounting position that you would want to consider unless you can be certain to protect the feedline from heat generated by the engine.

HAZMAT truck

For hazardous materials (HAZMAT) spills, a similar vac truck system may be used to recover liquid or semi-solid materials. Generally, any radio equipment installed in such vehicles should be rated as intrinsically safe. Many of the hazardous materials are flammable or explosive at certain concentrations (LEL or density), so all spark sources must be eliminated.

► *Radio installation problems* — To further complicate communication, workers may be wearing respirators and gloves. Have the operators check out the communications before you turn over the finished installation. Using oversized mic switches or placing speakers in unlikely positions may be required to overcome the limitations on the operator's ability to manipulate small objects and to hear well when

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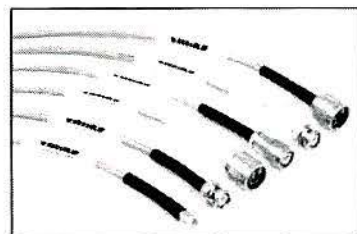
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Photo 8. Aftermarket floor mounts are a good choice for these large vac trucks.

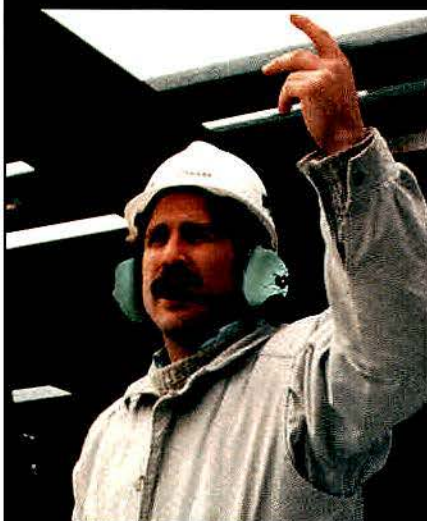
wearing the personal protective equipment (PPE). In some cases self-contained breathing apparatus (SCBA) may be used.

There are a host of accessories developed for use with fire protective equipment. Both HAZMAT and fire equipment operators use similar PPE. If the HAZMAT operating environment is new to you or your company, call some suppliers or the fire department to see what solutions they have found to be successful.



Photo 9. Two way radios are a key for effective use of these expensive, specialized trucks.

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Photo 10. An example of the extensive 'plumbing' that is routed under the operator's cab. Be careful.

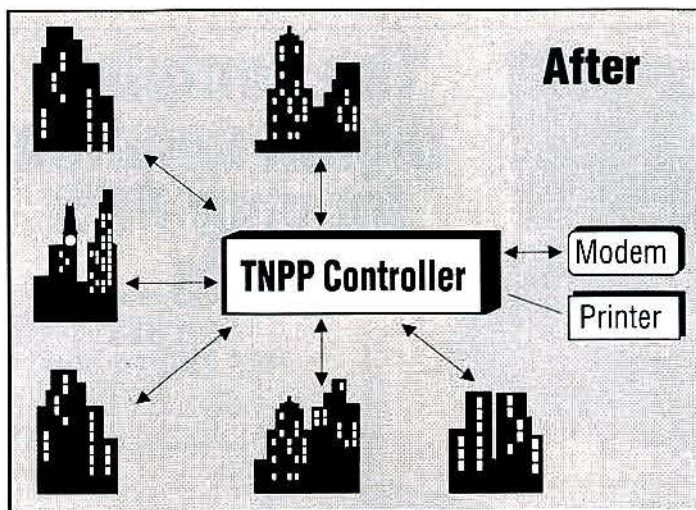
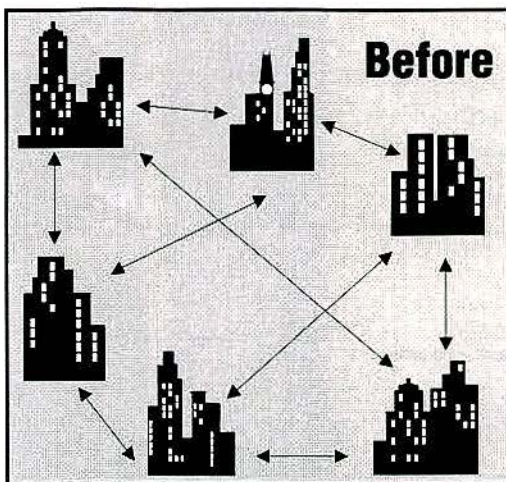
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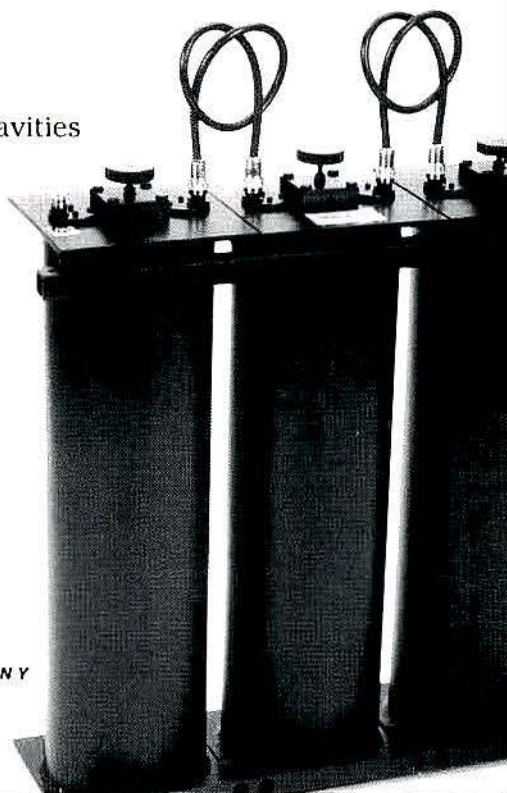
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fire officials. Asking the local fire code experts beats trying to read and interpret complex regulations.

► **Radio installation problems** — Positioning the R/T unit is usually easy. Because of the sheer size of the vehicle, the cabs are uncluttered and offer lots of potential mounting possibilities. (See Photo 3 on page 28.) Where care must be exercised is in the routing and connection of power wiring to the installed radio. Always check with the operator or maintenance supervisor before routing the power leads. Make sure that power scheme meets with their approval for safety's sake. Because these trucks have extensive grounding systems, "sneak" circuits are a real concern.

Sneak circuits are (with apologies to computer enthusiasts) "virtual" circuits that are formed when installed equipment allows current to flow around fuses or control switches. This phenomenon may seem puzzling, but is one of the key reasons I insist on putting fuses in both the positive and negative power lines for communications equipment. If you have not experienced this problem yet, that's fine, but do not overlook the simple safety step of fusing the power leads to prevent damage to equipment or vehicles.

Mounting antennas on fuel trucks is straightforward. In Photo 4 on page 28, you can see a glass-mount antenna that resolves two important points. This type of antenna mount reduces the concern about sneak circuits. It has the added bonus of reducing—if not eliminating—corrosion of the antenna mount where it touches the truck body. As always, follow the manufacturer's instructions and thoroughly clean the windows before installation. This cleaning is even more important in cold-weather operation areas. High-gain antennas mounted on the roof of the operator's cab may be inappropriate because of clearance problems with aircraft wing or fuselage surfaces. Check to be sure.

Mounting communication systems in vac trucks and fuel trucks poses some unique problems that an installer can overcome by making careful plans, by checking with the operator and by checking with other experts such as fire officials. Common installation techniques may cause sneak circuits to form that must be countered. Care and common sense should be enough to provide a professional, trouble-free installation. Thanks to Anthony Aquilano, Ernie Stoitenberg and Dan Schorr for the help and information on these "invisible" service vehicles.

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Servicing microwave links in two-way radio systems

A well-designed microwave communications system is extremely rugged and durable. With basic maintenance procedures, it will rarely malfunction. Here are some steps to take during service calls.

By Roald Steen

Microwave communications systems are found within many mobile radio systems. They are used to connect repeater locations to dispatch points and to connect repeaters with satellite receivers and voting units.

Microwave systems normally are well-engineered. Microwave communications first came into widespread use to connect TV broadcast stations with network studios and to connect parts of the nationwide long-distance telephone network. Both applications demanded extremely high reliability. Between a network headquarters on the East Coast and a TV broadcast station in the Midwest there may be 30 or 40 microwave repeaters. If any of the microwave repeaters fails, the network TV feed can be lost by the local television station. The rarity of such failures is evidence of microwave communications system reliability.

What does all this have to do with troubleshooting a microwave link that forms a part of a two-way radio system? Microwave systems are normally so reliable, it is only necessary to troubleshoot one when almost all other possible causes for a malfunction have been eliminated. Before going to work on the microwave system, be sure the malfunction does not lie in the repeater, the repeater control system or the dispatch console.

External causes of malfunctions

Microwave sites are often unattended and in isolated locations where they may be subject to accidents, weather damage or vandalism.

Steen is an electronics instructor and free-lance writer. He has worked as a two-way radio technician, and he lives in Woodbury, MN.

One microwave system in a water tower failed when the water control system malfunctioned and let several inches of water into the equipment building. Even so, the RF equipment was undamaged. The water had damaged the power supply in the bottom of the microwave system cabinet.

Nitrogen under pressure is widely used in waveguides to exclude moisture. In waveguides pressurized by nitrogen gas,

Microwave systems are normally so reliable, it is only necessary to troubleshoot one when almost all other possible causes for a malfunction have been eliminated.

waveguide malfunctions often are accompanied by loss of gas pressure. When properly built, a correctly pressurized waveguide system generally is not subject to internal ice or moisture buildup.

Waveguides also may be damaged by vandals using firearms. Unfortunately, operators of large microwave systems consider such waveguide damage to be common.

Preparations for service calls

Most of the radio circuits in microwave equipment use fairly low frequencies that can be measured with ordinary instruments found in most two-way radio shops. Servicing microwave systems may require special test instruments, such as a microwave wattmeter, a microwave fre-

quency counter and a spectrum analyzer that covers microwave frequencies. Much of the signal processing takes place at an intermediate frequency that eventually mixes with the microwave oscillator front end. The part of the receiving and transmitting system actually operating a microwave frequency may consist of one or a few modules.

The equipment manual is essential for troubleshooting microwave systems. It explains what to check and outlines a logical troubleshooting procedure.

Keep track of important readings from the indicator instruments that are part of the microwave system. Signal strength and output power should be logged. Logging this information whenever you service the microwave site may reveal problems as they develop.

If a backup or standby circuit is available, switch communications to it before you start servicing equipment in the malfunctioning circuit. Service work then can be done with minimal inconvenience to the microwave circuit users.

Microwaves can be a health hazard. Most microwave systems used with mobile radio systems are low-power systems, but take precautions. The eyes are the most vulnerable part of the body. Never look into a microwave waveguide or feedhorn. Also avoid looking into other parts of the microwave transmitting system when the power is on. Many equipment shelters will have stationary radiation monitors positioned around the room. When leaks are a potential hazard, initial attention should be given to these monitors.

Protective clothing is available for use around non-ionizing radiation (see "Use protective clothing for safety in RF fields," April 1994 issue). For a quick visual inspection to ascertain the location of a leak, a hood may suffice. For an

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extended service call where a circuit is active and prolonged exposure to a leak is possible, full protective gear may be required.

Systems troubleshooting

► **Antenna alignment**—One somewhat vulnerable part of the microwave communications link is the antenna aiming. A microwave system may require extremely precise aiming of the microwave anten-

nas at each end of the link. If one antenna moves out of position slightly, perhaps only a few degrees of arc, a problem may result.

Most microwave systems can monitor received signal level (RSL), so one of the first steps is to check it to verify proper reception. With a bidirectional microwave system, RSL at each end can be compared. With a one-way system, such as one that would connect a satellite receiver loca-

tion with a voting unit location, only the RSL at the receiving end can be checked.

If the transmitter power output is normal and the RSL differs greatly from normal, it may be necessary to have the antennas realigned by a tower crew. Small variations in RSL usually are unimportant because a typical microwave system is designed with as much as 40dB of safety margin over the limiter signal level. In strong and gusty winds, small received signal variations may be caused by the wind moving the antennas or towers at either end, although the microwave antenna mount should be made strong enough to prevent significant antenna movement.

► **Waveguide**—If high reflected power is indicated on the microwave wattmeter, the most likely cause may lie in the waveguide (or the coaxial cable) to the antenna. At the antenna itself, only malfunctions in the feed horn or feed antenna normally are capable of causing high reflected power. Even severe icing of the antenna rarely results in much reflected power.

When a wattmeter connected at the microwave transmitter indicates high reflected power, measure reflected power again at the point closest to where the waveguide exits the building. Low reflected power at this connection points to trouble within the building. High reflected power at this connection points to trouble outside, and it may be necessary to call in the tower crew. Remember to turn off the microwave transmitter before manipulating any couplings in the transmission line, as when inserting and removing a wattmeter.

Troubleshooting and replacing a long length of microwave waveguide or coaxial cable usually requires tools, instruments and capabilities that are beyond those of most two-way radio technicians.

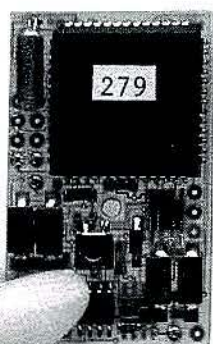
► **Power supply**—Many microwave system malfunctions are traced to the power supply. If there is no microwave signal at all, first check to see whether the power supply is on; if it is not, check the fuse.

It is common for isolated microwave sites to lose utility power. Systems designed for high reliability usually have backup power in the form of batteries, a fuel-powered generator or both to supply power when utility power fails.

The backup power system should be checked and maintained during a microwave site visit. Check the fuel-powered generator if there is one, and check battery voltages. Clean the battery terminals and replace any lost electrolyte with distilled water.

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Of course, the Super-S still provides all the standard features previously found in the FM/AM-1200S such as analog and digital meters for convenient operation regardless of the lighting conditions, 1 GHz RF generator, 1 kHz and variable frequency audio generators, duplex operation, 2 μ V receiver, 150 W

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only for refilling the batteries, but to use for flushing acid spills from skin, clothing or other surfaces.

Check the various power supply output voltages, and trace them to see that they reach the various circuit cards and modules within the microwave equipment.

► **Multiplexer cards**—A single analog microwave link may be served by numerous multiplexer cards. Malfunctions often are caused by problems in a multiplexer

card, as indicated when one channel malfunctions, but the other channels continue to work.

The various multiplexer cards are controlled by a system of oscillators at different frequencies. Most commonly, each multiplexer card delivers a single-sideband signal as its output. The multiplexer cards and their levels can be checked with instruments such as a frequency-selective voltmeter and a spec-

trum analyzer. Overmodulation on one of the multiplexer cards can cause interference with other channels.

Even when checking multiplexer cards, a word of caution is in order. Do not attempt to align or to adjust anything on multiplexer cards, unless you are fairly certain that you have found the cause for the problem. Otherwise, you may do more harm than good to the system.

Although the multiplexer cards use single-sideband modulation, the baseband signal (composed of all the single-sideband channels from the multiplexer cards) is frequency-modulated onto the microwave carrier. The microwave signal bandwidth can be huge, compared with narrowband FM signals used in mobile radio systems.

► **Wave tubes**—Most low-power microwave systems use solid-state microwave transmitters. When replacing a traveling wave tube in a high-power system, be extremely careful. Many traveling wave tubes are fragile (and expensive). If a tube breaks during removal or replacement, it will be difficult to remove the glass splinters inside the traveling wave tube mount. Another reason for extra caution when working on a traveling wave system is the high power-supply voltage.

Repair verification and prevention

Some microwave systems have a special voice communications channel for use while troubleshooting. Otherwise, on-site communications may be conducted by telephone or portable radio. Once the malfunction is repaired, test the microwave link with the help of someone at the other end to verify proper operation. Network management systems are available.

While you are at the microwave site, it is a good idea to do some basic housekeeping. Keep the site clean, and keep parts, equipment and safety supplies well organized. During the winter, you may want to shovel snow from the access path. During the summer, mowing and trimming may be necessary—both to keep access open and to eliminate concealment for trespassers. Security and safety measures (locks, chains, fences, fire alarms, remote monitors, etc.), particularly in a remote location, should be checked. Unmonitored tower lights can be checked during the daytime by covering the photocell that activates the lights or by using a switch that bypasses the photocell.

A well-designed microwave communications system is extremely rugged and durable. With these basic maintenance and service procedures outlined above, you will maintain the reliability of your system.



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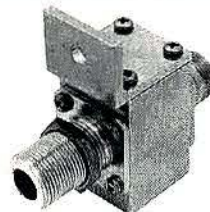
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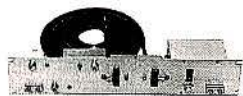
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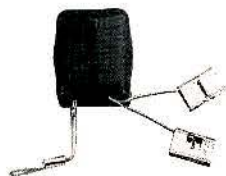
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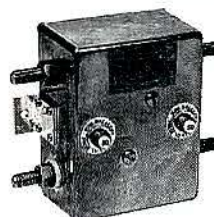
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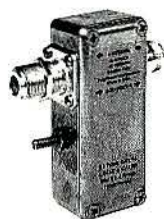
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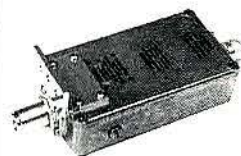
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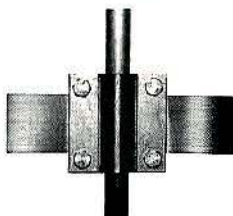
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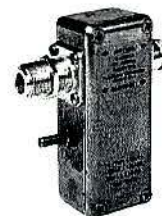
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TOWER/POWER/PHONE



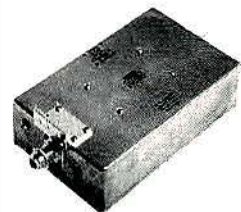
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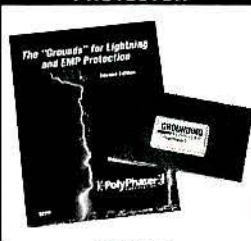
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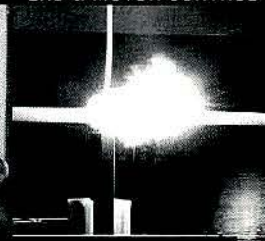
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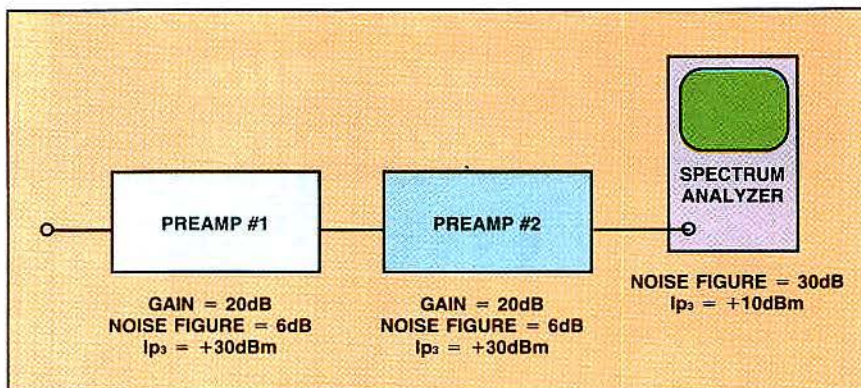
Technically speaking

(continued from page 8)

In our example, the preamplifier Ip_3 is +15dBm and the spectrum analyzer Ip_3 is +10dBm. The difference is 5dB, so we look in Table 1 for 5dB. The nearest comparable figure is 6dB, which correlates to a degradation of -3.5dB in the Ip_3 figure. The 5dB difference between the preamplifier and the spectrum analyzer Ip_3 figure would cause more than a -3.5dB degradation but less than the -4.6dB figure that correlates to the 3dB figure in the left-hand column of the table. Simple linear interpolation yields an Ip_3 degradation figure of -3.9dB. Thus, the overall third-order intercept point (Ip_3) is now

$$+10\text{dBm} + (-3.9\text{dB}) = +6.1\text{dBm}.$$

This means that at the preamplifier input, the third-order intercept point will be 20dB below +6.1dBm, or -13.9dBm. Thus, we have gained in the low-signal performance and lost ground in the high-signal performance of the spectrum analyzer by adding the preamplifier. You can see by looking at Table 1 that if we use a preamplifier that has a much higher third-order intercept figure (Ip_3) than the spec-



trum analyzer, then the amount of degradation of the Ip_3 point is much less. For example, Table 1 shows that if the Ip_3 of the preamplifier is 20dB more than the Ip_3 of the spectrum analyzer, the overall degradation of the Ip_3 is only 0.8dB.

What happens if we cascade two preamplifiers ahead of the spectrum analyzer input? Let's analyze an example to see the results. Figure 2 above shows the

same spectrum analyzer preceded by two preamplifiers connected in cascade ahead of the input. Both preamplifiers 1 and 2 have identical specifications for gain, noise figure and third-order intercept (Ip_3). These figures are listed on the block diagram in Figure 2. The total gain of the preamplifiers is 40dB or multiplication factor of 10,000. The overall noise factor is calculated follows:

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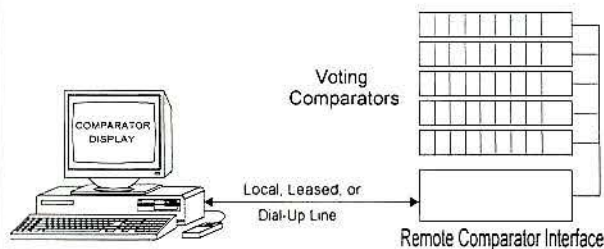
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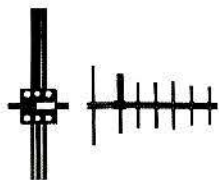
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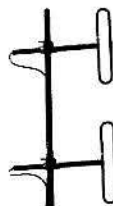
TC860, also known as Celco Ceramic Trunking Combiner. born 5-25-91; size 7x19x14"; 36 lbs; rugged bld; 125 watts, alum finish. Wanted by SMR operators who want only the best.



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ANT450D3, also known as Dipole Array Antenna. born 9-14-58; known associates: other antennas in other freq bands and gain. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted by tower operators with the worst possible problems.



PRINTS
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Industry Top Ten Product

Model 44AP, also known as the Broadband RF Wattmeter. born 6-11-78; weight 4 lbs; rugged bld; 500 watts; gray comp; operates alone, no known associates; distinguishing marks: leather band on top, sample port right side. No known enemies, has been spotted worldwide.



R. Middle

Industry Top Ten Product

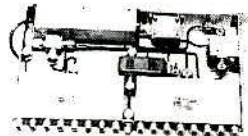
PMU1C1S, also known as Power Monitor Unit. born 4-23-95; sml bld; blk, red eyes glow in dark. Wanted for monitoring ant VSWR and TX power. Notorious for working multiple freq in all bands. Known associates RS232 and RS485.



R. Index

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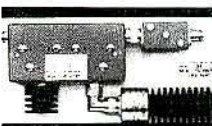
TWR816-860-1RTT, also known as Compact Receiver Panel. born 8-14-93; exceptional small build, likes to associate with multiple frequencies. Quiet 2.5 dB noise; modular; has been known to redundantly switch to 2nd channel if injured; likes living in harsh locations. Wanted for resisting interfering signals.



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TS450PB1, also known as IM Suppression Panel. born 7-12-75; rugged bld; black & blue marks on body; 5 lbs; 19"x5.25"x1.50 w; 150 dB; wanted by the FBI for killing intermodulation; likes isolation. Reward is offered for protectionism.



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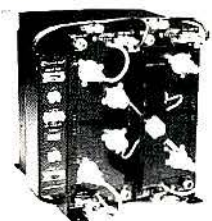
PM5C1S, also known as Automatic Alarm Panel. born 2-23-81; brushed alum; 1.4 lbs; 19"x3.5"; Known associates: likes to snitch on bad trans & ant; needs to be placed inline; violently resists high VSWR; likes power. Do not approach, will call you.



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TATC8944, also known as Cellular Auto Tune Ceramic Combiner. born 4-1-92; size 10.25W x 10.75H x 12.75"; 36 lbs; heavy bld; black finish; easy to install. Wanted by Cellular operators for retrofit or new installations, both in USA and foreign countries.

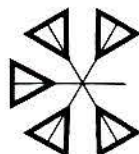


L. Thumb

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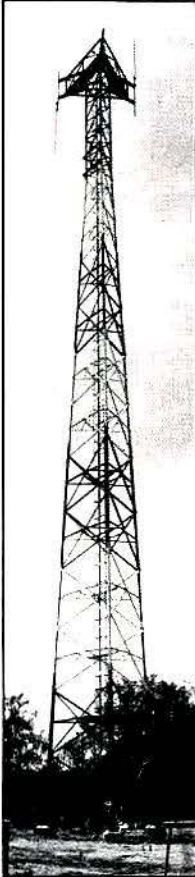


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$$= 4 + \frac{3}{100} + \frac{999}{10,000}$$

$$= 0.03 + 0.0999 = 4.13$$

This is converted to noise figure by $10 \log (4.13) = 6.17\text{dB}$. Thus, the overall noise figure has improved by $30\text{dB} - 6.17\text{dB} = 23.8\text{dB}$.

Now, what about the third-order intercept, Ip_3 ? Referring again to Figure 2, we see that the two preamplifiers have the same Ip_3 of $+30\text{dBm}$. Referring to Table 1 again, when the difference between the two preamplifiers is 0dB , the table indicates a degradation of -6dB at the output of preamplifier 2. Thus, the Ip_3 at the output of preamplifier 2 is $30\text{dBm} + (-6\text{dB}) = +24\text{dBm}$.

This is 14dB greater than the spectrum analyzer Ip_3 , so we refer back to Table 1. Since 14dB is not listed, we can use the figures for 10dB and 15dB and interpolate. For 10dB , the degradation would be -2.4dB and for 15dB the degradation would be -1.4dB . By interpolation, we derive a figure of 0.8dB to be added to -2.4dB to get $+1.6\text{dB}$ degradation. We apply this conversion factor to the spectrum analyzer Ip_3 of $+10\text{dBm}$ to get $+10\text{dBm} + (-6\text{dB}) = +8.4\text{dBm}$ for Ip_3 .

Again, this is a worst-case scenario where all the IM signals combine in phase.

Summary

When a preamplifier is used ahead of a spectrum analyzer, the maximum input to the preamplifier should not exceed the maximum rated input to the spectrum analyzer *minus* the gain of the preamplifier. The small-signal performance of the spectrum analyzer will be enhanced by a good preamplifier, but the dynamic range and the third-order intercept point, Ip_3 , will be reduced. Preamplifiers can be used to detect low-level signals. Don't use preamplifiers unless it is necessary to boost the signal level, and avoid their use in the presence of very strong signals. Front-end overload comes very quickly!

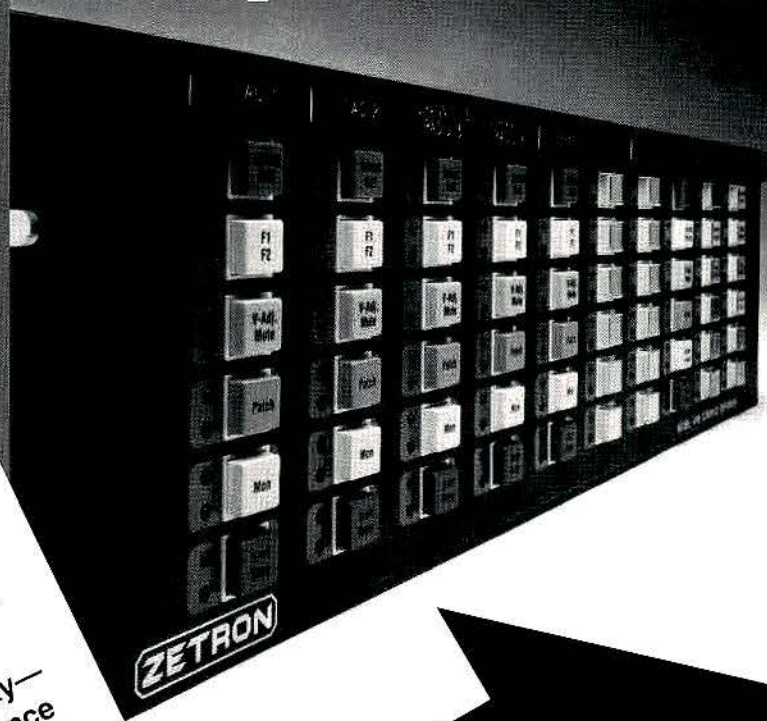
Next time we will look at more tips and techniques for the spectrum analyzer. 'Til next time—stay tuned!

References

Coombs, Clyde F. Jr., *Electronic Instrument Handbook*, 1995, New York.
Tektronix Test & Measurement, *Choosing a Preamplifier for Use with a Spectrum Analyzer*, 1992, Beaverton, OR.



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The tomatoes of wrath

By Robert H. Schwaninger Jr.

In Steinbeck's poignant *The Grapes of Wrath*, we witness the Joad family's tragic fall from noble, yeoman farmers to wretched itinerant workers after the sale of their family farm to pay back taxes and bank debt. Our hearts cry out for these unsophisticated victims of the Depression who do not fully comprehend how bankers, revenue agents and the forces of nature can combine so swiftly to bring misery and ruin. Through them, we appreciate the fragile nature of our own economic existence and the speed by which circumstances can rip away our security.

We also understand the tenuous economic status of those noble TV broadcasters, whose livelihoods are threatened by revenue agents seeking to sell their spectrum farms. The recent barrage of advertising, warning us of broadcasters' col-

lective plight, must move us to rally to their aid and pass the hat at our video barn raisin' to save that cherished American Dream, free television.

Just a few years ago the broadcasters told us about a new crop that they were going to plant, High Definition Television (HDTV). If we would give them a couple of acres of radio spectrum, they'd do the plantin' and the plowin' and all the backbreaking work to make sure that our country was served the best television on the planet.

Congress and the FCC believed the broadcasters and gave them the acreage they needed: a 6MHz parcel spread across the radio spectrum with a high, wide fence



"THIS IS YOUR TEN-FOOT TALL TOMATO?!!!"

to make sure nobody sneaked onto it to do a little sharecropping. That virgin land of opportunity was set aside in trust, and it was fertilized liberally with speeches from commissioners, Congressmen and the like. They patted themselves on their collective back for making the sacrifice necessary to bring the American public news, sports and

entertainment (and of course, commercials) with improved clarity. It would never "snow" on this land.

Since that time, the American public has awaited the ten-foot-tall tomato (HDTV) that the land was to produce. Every few months, the television broadcasters tell us that they are just a little closer to the start of planting season—as soon as they can find someone who really wants a ten-foot-tall tomato (or more importantly, someone who would shell out over a thousand bucks for a new TV set to receive this dream vegetable).

Even when Congress caught auction fever, agreeing to sell every right-of-way, white space and spectrum block that could be found, the TV broadcasters were still given a free pass. The law that began auction authority in 1993 and the recent Telecommunications Act of 1996 both exempted broadcasters, giving them the same status as local governments.

Successive chairmen of the FCC, including Reed Hundt, applauded the extension of the broadcast exemption, claiming that auctions of television spectrum would threaten the basic tenets of free speech. The First Amendment was trotted out more times than a prize pig at the county fair, and Hundt held up the blue ribbon. Broadcasters were lauded as stout fellows, who unselfishly delivered their programming to the public for free, and accepted money only from those that deserved to pay—advertisers.

Lately, Congress has been eyeing that free acreage and noticing that the broadcasters haven't brought in a crop yet. HDTV is still under the ground, waiting to sprout...someday. Legislators like Senator McCain of Arizona are getting a little antsy, saying, in effect, "We gave

Schwaninger, MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

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before
IT STOPS
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BUSINESS.

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prevent water migration.*

Trilogy 
COMMUNICATIONS INC.

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Circle (45) on Fast Fact Card

Regulating technology

you a chunk of ground, and we expected you to produce."

So, the TV broadcasters are crying foul. Just because every other telecommunications farmer has been forced to pay for radio spectrum, subjected to auctions, and had their taxes raised is certainly no reason to sell the ground that will someday bring the American public its first ten-foot-tall tomato. The broadcasters hurl invectives at any such suggestion, asking

the American public to chastise those Congressional ingrates.

Hundt has waded in on the side of the broadcasters, saying that they ought to be able to raise regular ol' peas or corn (or a little paging) on the land, until they can find a way to deliver their big love apple to market. Needless to say, the pea farmers and the corn producers (and established paging companies) aren't too thrilled with the idea of broadcasters competing with

them using free land that was set aside for totally different purposes.

The broadcasters made a few mistakes over the last few years that have caused them to get crosswise with their telecommunications neighbors. When PCS operators were told that they would have to pay for spectrum, the broadcasters didn't fuss. When small operators of local two-way radio services were told to move over for large companies looking to consolidate radio spectrum for sale, the broadcasters were whooping it up at the National Association of Broadcasters convention-and-barn-dance. When paging companies were recently tapped as the newest victims of the FCC's auction fever, the broadcasters sat on their porches, rocking and muttering, "We just take care of kin."

Broadcasters' clannish behavior sets them apart from their neighbors. Their attitude of superiority and cockiness has not prepared them for the shock of changing political times, where a senator might ask aloud the unthinkable question, "What's so special about these guys?"

The revenue man is everywhere these days. He's bustin' up, bundlin' up and sellin' off every megahertz in sight. The appetite for new taxes, new revenues and new services is so voracious, one wonders if it will ever be satisfied. The Telecommunications Act has language that is meant to protect small companies, women- and minority-owned companies, and rural telephone companies from the auctioneer's gavel, yet these entities have been the worst-impacted groups.

Moving like a twister across the landscape, the FCC has swept up small spreads in its path and redeposited the valuable spectrum topsoil on the land of the richest farmers and plantation owners. Small broadcasters could be next as they try to cling to the free soil that Congress gave them so few years ago. Small two-way operators and local paging companies already hit by the auction storm are unsympathetic to the petulant cries of broadcasters, "It's okay to destroy those farms, but mine is somehow special."

It is hard to imagine Rupert Murdoch sitting next to a campfire, with the flickering, ghostly light dancing across a weathered face marked by the creases of sun-baked labor, saying, "Wherever there's an FCC auction guy tossin' a little paging company off the air, I'll be there. And whenever there's a Congressman settin' his sights on a chunk of a towing company's spectrum, I'll be there."

The truth is, the broadcasters weren't there. Now they are finding out what being neighborly is all about.

GETTING MAXIMUM PERFORMANCE FROM EVERY INSTALLATION

Bird's New Antenna Tester Eliminates The Guesswork!

Installing and troubleshooting cellular and mobile radio antennas can be a guessing game. Undetected problems with connectors, cabling, antenna placement — even glass characteristics — can drastically affect performance.

Bird's AT-800 rapidly tests any 806-960 MHz antenna. The self-contained RF source is preset for cellular bands. Or select your own frequency range. A 100-point scan of VSWR, Match Efficiency, or Return Loss is graphically displayed within a second. A simulated analog meter speeds single frequency tuning, and field strength mode verifies hand-helds. PASS-FAIL testing, audible indicators, and numerous other features make it easy to be sure. And the AT-800 is remarkably easy-to-use.

With the AT-800, installers, engineers and technicians don't have to guess anymore. Contact Bird now for more details.

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Electronic Corporation

U.S. Headquarters:

Tel: 216-248-1200
Fax: 216-248-5426

Western U.S. Sales Office:

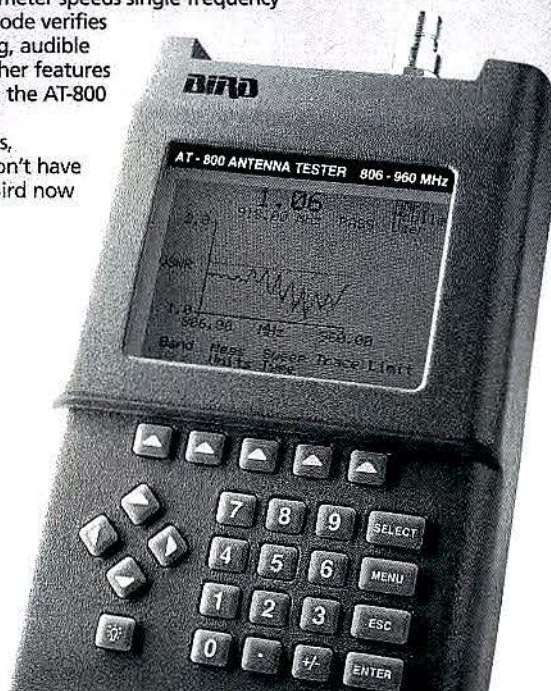
Tel: 805-646-7255
Fax: 805-646-0275

Pan-Asian Sales Office:

Tel: 65-2992537
Fax: 65-2998509

European Sales Office:

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Fax: 44-1-442-870148



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Circle (47) on Fast Fact Card

FCC primary status revoked on 125 channels inside 220MHz-222MHz band

The National Telecommunications and Information Administration (NTIA) announced it has revoked the federal government's primary status on 125 channels inside the 220MHz-222MHz band, channels currently allocated equally to the federal government and to private users. NTIA Administrator Larry Irving said that relinquishing the government's primary

status will increase the spectrum's auction value by allowing the private sector bidders to be the primary user. NTIA is also recommending that the Federal Communications Commission (FCC) adopt a combinatorial approach to auction the 220MHz-222MHz band for commercial mobile services, allowing bidding on a package of licenses.

Geotek introduces digital mobile communications network in Boston

Geotek Communications, Montvale, NJ, launched its digital mobile business system in the greater Boston area. The network provides integrated voice and data communications and is based on FHMA digital technology. Information will be provided to mobile workers through the Geotek Mobile Workstation that combines the functions of a cellular phone, two-way radio, pager and laptop computer.

Celwave announces bulletin board system with antenna pattern access

Celwave, Marlboro, NJ, has announced a new bulletin board system featuring digitized patterns, software and bulletins. Access is available to Celwave's digitized antenna patterns and antenna pattern reader. The bulletin board system operates at speeds as fast as 28.8kbps and uses standard modem settings of 8-N-1.

Chadmoore completes stock placement in Switzerland

Chadmoore Wireless Group, Las Vegas, has completed a \$2.5 million private placement of 250,000 shares of its series A convertible stock with Flurina Development, S.A., Zurich, Switzerland. According to Chadmoore, this agreement will accelerate their NASDAQ small cap listing process and the construction schedule for their 800MHz SMR operations in the Midwest and Southeast.

FCC names PCIA as clearinghouse

The Federal Communications Commission (FCC) has named the Personal Communications Industry Association (PCIA), Alexandria, VA, as a tentative clearinghouse for PCS microwave relocation cost-sharing. The FCC adopted PCIA's proposed cost-sharing plan to promote the relocation of microwave systems, to benefit microwave incumbents and to distribute relocation costs more equitably among PCS licensees.

PageNet acquires 126 licensees

PageNet, Plano, TX, has acquired 126 licensees in the FCC's 900MHz SMR auction for \$45.5 million. The frequencies will be used for existing and future services, including PageNet's new two-way, high-capacity wireless network.

IWCE posts record attendance

The International Wireless Communications Expo (IWCE), Las Vegas, April 24-26, posted record attendance this year with nearly 11,000 total delegates and 20% more exhibit space than last year.

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It's very easy to use...just turn it on and talk. Get crystal clear audio even at high volume. Ideal for construction, utilities, security and industrial applications. Makes a great rental radio!

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It's all the quality, extra value, top performance and rugged reliability you expect from Midland.

Models 70-148/248
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FAX: 905/839-7411
Quebec 1-800/561-6190
FAX: 514/923-2003

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70-147 Portable

For applications such as warehousing, shipping, building maintenance, security and agriculture, Midland offers the 5-watt 20-channel Model 70-147. Frequency range 148-174 MHz.
SUGGESTED U.S. PRICE: \$379.95*

Circle (48) on Fast Fact Card

Trimble gets Texas AVL contract

Trimble, Sunnyvale, CA, has been awarded an automatic vehicle location (AVL) system integration contract by the Montgomery County Hospital District (MCHD) in Texas. Trimble will equip 30 vehicles with its Global Positioning System (GPS)/AVL subsystem used to locate, manage and dispatch vehicles for enhanced fleet operations. Additionally, Trimble will provide geographic information system (GIS) services to be used as the source for Trimble's StarView map display database and computer-aided dispatch (CAD) geofile. The GPS/AVL subsystem includes a PCS-200 intelligent data controller with a built-in GPS receiver, an EchoXL message data terminal, and base station software packages for AVL management and communications control. These products work together to track vehicles or to report vehicle/crew status and to provide as many as five reports per second to give the dispatcher continuous feedback from the fleet.

360° Communications reaches agreement with IBM

360° Communications, Chicago, a spinoff of Sprint, has joined forces with IBM to provide mobile data solutions to customers. 360° Communications will provide mobile data services including both circuit-switched cellular and cellular digital packet data (CDPD). IBM will provide solution development and implementation including ongoing customer support.

Sinclair expands manufacturing and distribution center

Sinclair Technologies, Aurora, Ontario, Canada, has expanded its manufacturing and distribution center. The new 12,148 square-foot facility, located in nearby Newmarket, will accommodate Sinclabs engineering and manufacturing and will serve as a warehouse and distribution center for Sinclair and Sinclabs. This move will free up space at the Aurora facility to develop new technologies, particularly in the areas of PCS/PCN and GSM.

E.F. Johnson Services created

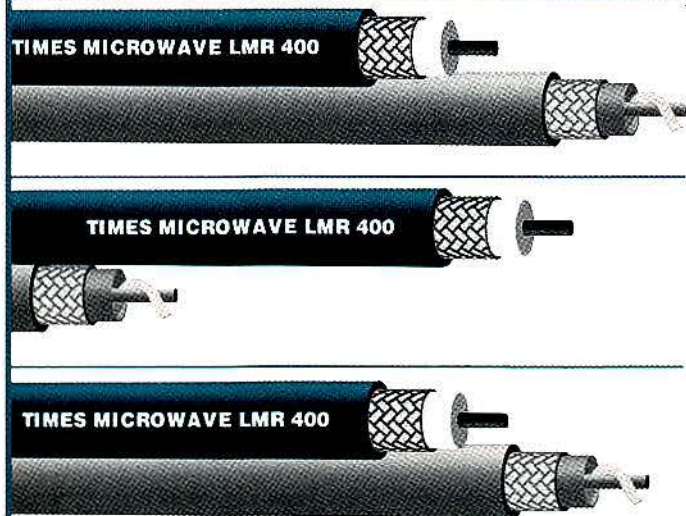
E.F. Johnson has announced the formation of E.F. Johnson Services to offer a variety of communications facility installation and construction-related services targeted to the emerging personal communication service (PCS) industry, cellular telephone providers and specialized mobile radio (SMR) operators. James B. Potter, director of operations, will handle the division's sales, administration and day-to-day operations.

UTC forms business development section to promote opportunities

UTC, The Telecommunications Association, Washington, an international trade association, has formed a business development section in reaction to growing interest from a number of utilities. The business development section will identify and promote business opportunities for UTC members; act as a forum for members to discuss, review and analyze potential business opportunities;

assist members in leveraging their telecommunications and information-related assets; and identify and assess legal and regulatory barriers to pursuing business opportunities. In the first meeting, speakers from AT&T and ICG addressed the topic of strategic marketing, and UTC's senior staff attorney discussed business development aspects of the Telecommunications Act for utilities.

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Times Microwave LMR®-400 . . . The benefits are clear!

Lower Attenuation — The closed cell foam of LMR-400 provides the lowest loss of any RG-8 size cable on the market - only 3.9 dB per 100 feet at 900 MHz.

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Lower Cost — LMR-400 is priced competitively with air dielectric designs. Its superior construction results in longer life and high reliability for far lower life cycle cost.

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<http://www.timesmicrowave.com>

Circle (49) on Fast Fact Card

Antenex expands in Illinois

Antenex, Glendale, IL, has opened a new facility in Illinois. The new plant will increase production of its current yagi, fiberglass and vertical aluminum base antenna line. The plant will also serve as its new high tech R&D facility allowing Antenex to develop a new line of advanced high end base antennas for two-way radio, cellular, data telemetry and PCS communications.

Eagle Telecom International/Eagle Aerospace has been acquired

Eagle Telecom International/Eagle Aerospace, Houston, TX, has been acquired by an investor group headed by Dr. H. Dean Cubley. The company's long-term goals will be to provide resources for expanded production capability, increased international marketing activities and new product development.

Telltabs acquires Steinbrecher

Telltabs, Lisle, IL, has acquired Steinbrecher, Burlington, MA, for \$76 million. Initial efforts of the combined companies will be directed to the Latin America and Pacific Rim telecommunications industries.

Metrocall acquisitions raise customer base by 500,000

Metrocall has acquired Page America, Hackensack, NJ, for a total purchase price of \$78.5 million. This acquisition will add about 220,000 subscribers to Metrocall's customer base.

Metrocall, Alexandria, VA, has acquired all of the midwest business assets of Source One Wireless, Chicago. This acquisition will add about 300,000 subscribers to Metrocall's customer base.

Ericsson, Omnipoint sign agreement on PCS technology

Ericsson, Richardson, TX, has signed an agreement with Omnipoint, Colorado Springs, CO, for personal communications services (PCS) equipment using Omnipoint's IS-661 and Ericsson's PCS 1900 technologies. Ericsson will purchase a multi-million dollar license to market Omnipoint's IS-661 technology.

Paging Partners, Motorola Emlarc sign network services agreement

Paging Partners, Freehold, NJ, has signed an agreement with Motorola Emlarc to resell branded information services. Paging Partners will deliver the services, along with paging on their network, from New Hampshire to northern Virginia. The first service to be provided is ESPNET TO GO, a sports information service that provides game information and score updates from ESPN.

Data Critical receives patents for paging data technology

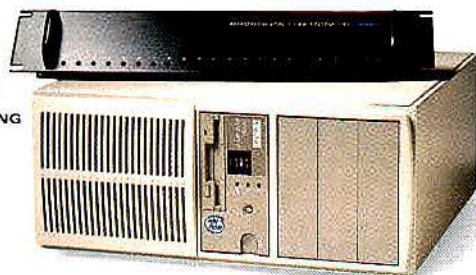
Data Critical, Redmond, WA, has been awarded two patents for its Data-through-paging (DTP) technology. One patent covers the "packetizing" component of the company's protocol where text or graphical data is compressed and divided into packets for transmission. The other patent covers the encryption component that allows data to be keyword-encrypted and converted into an alphanumeric code for transmission over E-mail or paging systems. The data is then decrypted on the receiving end and displayed on hand-held or desktop computing devices.

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Product/services showcase

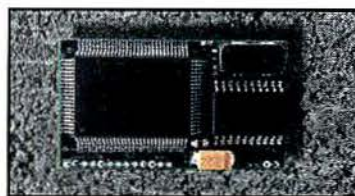
The following pages contain mobile radio, paging and cellular products and services of advertisers in this issue. Information is provided by the advertisers. For more information on these products, circle the corresponding Fast Fact number found on the card on page 97. Also, refer to the Ad Index on page 96 for the page reference to the company's advertisement.

Multichannel remotes



The MCR Alpha series remotes from CPI Communications provides remote control of Motorola's Maxtrac, Radius GM300, Kenwood TK630, TK730, TK830 and Midland's Syn-Tech XTR radios. The remotes display the channel number and as many as ten characters of a user-programmable name. Programming is done from the front panel, no special cables or PC required. Programming can be cloned from one remote to another.

Circle (401) on Fast Fact Card



Digital scrambler

The SC20-500 Phoenix scrambler from Transcript International uses DSP technology to provide next-generation digitally-scrambled audio. Ideal for security-conscious public safety agencies, business and industry, and international government agencies.

Call 800-228-0226.

Circle (402) on Fast Fact Card



Miniature two-way radio

The Micro-Talk two-way radio from Advanced Videotech offers the power of radios twice its size. By taking advantage of advances like micro-miniature circuitry and surface-mount technology, MicroTalk generates less heat than other radios to improve reliability and extend service life.

Advanced Videotech
800-233-0013

Circle (403) on Fast Fact Card



Fall protection systems

- Fully certified for all towers
- Easily installed on new and existing towers
- Rugged design for multiple users
- OSHA-compliant

Trylon Manufacturing
519-669-5421; Fax 519-669-8912

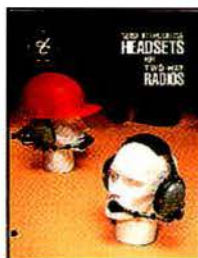
Circle (404) on Fast Fact Card



RF coaxial attenuators

Bird Electronic has introduced 14 dry coolant TenuLine attenuators and Termaline terminations. All attenuators feature bi-directional operation. Both attenuators and terminations include models ranging from 2W to 100W. Call for a free brochure. 214-248-1200; Fax 216-248-5426

Circle (405) on Fast Fact Card

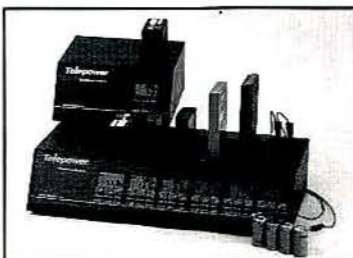


Noise-attenuating headsets

A brochure from David Clark Company provides information and specifications for the complete line of noise-attenuating headsets, radio adaptors and accessories for two-way radios, including the series 6000 headset with noise-canceling mic and adaptor cords.

David Clark
Worcester, MA
508-751-5800; E-mail dcci@tiac.net

Circle (406) on Fast Fact Card

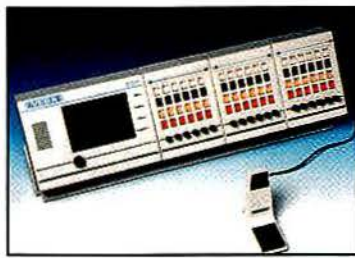


Conditioner upgrade kit

JBro's upgrade kit enables NiCd battery maintenance systems to condition and analyze NiMH batteries. The system uses software algorithms unique to NiMH battery formats.

JBro Batteries
800-323-3779; Fax 800-237-6435

Circle (407) on Fast Fact Card



Desktop control console

The model C-6024 from Vega offers ease of use with its touchscreen and independent switches for line selection and instant PTT. The microprocessor-based, multiline, multi-format, radio console handles as many as 24 lines.

Circle (408) on Fast Fact Card

Product/services showcase



Radio direction-finding system

Doppler System's 6000 series RDF system features enhanced sensitivity and bearing accuracy.

The DDF6000 processor display offers accuracy of 2° over an operating range of 125MHz-1,000MHz when configured with the proper site antenna and receiver. For literature, prices and demonstration disks, call 602-488-9755; Fax 602-488-1295.

Circle (409) on Fast Fact Card



Four-channel portable

The TK-260/360 VHF/UHF portable radio from **Kenwood Communications** weighs 14 ounces and includes built-in QT/DQT and two-tone. Features include four-channel capacity, programmable power, busy-channel lockout, time-out timer, battery power-saver circuit, low-battery alert and a heavy-duty antenna mount.

800-950-5005

Circle (410) on Fast Fact Card



Cable/antenna analyzer

Hutton Communications offers the Wiltron Site Master for VSWR/RL measurement and fault location. A Windows-based environment allows PC downloading.

888-4-HUTTON

Circle (411) on Fast Fact Card



Cellphone amplifier system

Larsen Electronics' Uplink powered cellphone amplifier enhances the cellular system by moving the transmit signal outside the vehicle and restoring it to its original strength.

Circle (412) on Fast Fact Card

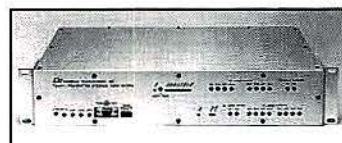


Trunking repeater/interconnect manager

The LT-4900 LTR RIC panel from **Connect Systems** includes as standard features many innovations available only as options on other brands. The panel's design allows channel sharing with conventional systems, which makes the switch to LTR easy and painless.

Connect Systems
2259 Portola Road
Ventura, CA 93003

Circle (413) on Fast Fact Card



Transmitter steering controller

The TSAM-1 transmitter steering controller from **CTI Products** works with existing comparators and receiver voting electors to steer eight transmitters. It includes fully programmable control tone generation and CTI Products' exclusive Smart-Steer algorithm. It is expandable to 64 transmitters.

513-595-5900

Circle (414) on Fast Fact Card



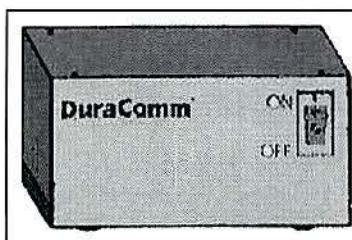
Signal analysis system

Survey Technologies manufactures and sells the STI-9100 series mobile signal measurement and analysis system.

The results created by the system graphically display the vast amount of measurement data in clear, concise, understandable reports showing levels of signal strength across geography.

503-848-8500; Fax 503-848-8534

Circle (415) on Fast Fact Card



Desktop power supply

The super-quiet 22A desktop power supply from **DuraComm** features auto reset and is switchable, 110V/220V. Weighing less than 3 pounds, the unit provides ac/dc line filtering, MOV line input protection and overvoltage/current protection. Supplies for 7A, 11A, and 15A are also available.

Circle (416) on Fast Fact Card

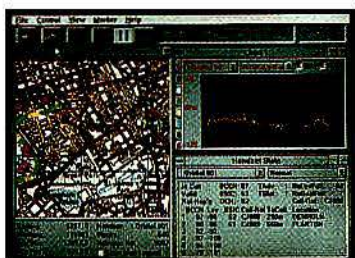


Transmitter, tracker

The Duet is a wireless 10W CDMA transmitter and tracking receiver for RSSI, BER and multipath analysis.

Berkeley Varitronics Systems
255 Liberty St., Metuchen, NJ 08840
908-548-3737; 908-548-3404

Circle (417) on Fast Fact Card



Digital measurement system

Grayson Electronics division of Allen Telecom Group introduces the next-generation feature set for its measurement platform. The Surveyor displays layer-3 message decoding, locations of hand-offs and dropped calls.

Grayson Electronics
800-800-7465; Fax 804-385-7692
Circle (418) on Fast Fact Card



Heavy-duty paging antenna

The HD9-92040 9dBd omnidirectional paging antenna from Hustler features a solid mechanical design and a 2" fiberglass radome rated for 150mph winds. The 920MHz-940MHz antenna offers outstanding fringe area performance and is dc grounded for lightning protection.

Circle (419) on Fast Fact Card



Consoles, workstations

Modular Communication System's consoles and stand-alone dispatcher workstations include the Ultra-Com PRO, which features "Screenmaker" and "Customizer" programs allowing the user to modify screens for specific requirements.

Circle (420) on Fast Fact Card

Air-dielectric radiating cables



Trilogy Communications introduces RMC² radiating cables for RF-restricted areas (buildings, subways, tunnels, etc.).

Product features include the only hermetically sealed low-loss air-dielectric cables available and they require no pressurization, no soldering for connectorization, and RMC² costs far less than corrugated copper cables. Available in 50Ω and 75Ω.

Circle (421) on Fast Fact Card



Shared repeater tone panel

- Desktop/Rackmount
- 157 Subscribers, 51 CTCSS/106 DCS
- DSP enhanced decode and talk-off rejection
- CW ID per subscriber
- Time and hit counter
- Local/Remotely programmable (DTMF/Menu-driven RS-232)

Communications Specialists
800-854-0547 FAX 800-850-0547

Circle (422) on Fast Fact Card



UHF compact hand-helds

Only 5 1/2" tall, Icom America's IC-F30LT VHF and IC-F40LT UHF hand-helds have an eight-digit alphanumeric display and 96 memory channels. The radios offer 5W of programmable power. The VHF covers 136MHz-150MHz, and the UHF model covers 400MHz-430MHz

and 430MHz-470MHz.
206-454-8155

Circle (423) on Fast Fact Card



Vehicle tracking system

This automatic vehicle tracking system's features include Windows compatibility, logging/playback functions and various mapping/display options for portable or fixed-site systems.

Corp Ten International
800-411-2675; Fax 410-583-0023

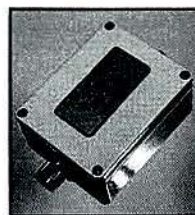
Circle (424) on Fast Fact Card



Full-scan analyzer

The 486-based COM-120B from IFR Systems provides near real-time spectrum analyzer and scope displays with virtually no keyboard buffering. It includes a crossband duplex system, a digitized full-scan spectrum analyzer with optional tracking generator and a PCMCIA memory card. Options include POCSAG, Clearchannel LTR, EDACS and AMPS test capability.

Circle (425) on Fast Fact Card



Medium wave isolators

Use existing AM broadcast towers for VHF, UHF, PCS or cellular antennas.

The MWI series isolators from Eagle can handle 2,000W of medium-wave power as well as 500W of through power. Other models can handle 10kW medium-wave and 3.0GHz through power.

Eagle
P.O. Box 4010, Sedona, AZ 86340
520-204-2597; Fax 520-204-2568

Circle (426) on Fast Fact Card

Product/services showcase

Communication structures



Valmont Industries manufactures steel structures for communications systems, including tapered tubular monopoles, self-supporting and guyed towers, at plants in North America

and Europe. Contact for structure requirements, stocking programs for quick delivery or that special need for a camouflaged communication structure.

Circle (427) on Fast Fact Card



Two-way radio batteries

Centurion International, quality manufacturer of batteries and antennas, has introduced new pricing on popular two-way radio batteries. We're the industry's value-packed replacement battery specialist.

For your local distributor, call 800-228-4563

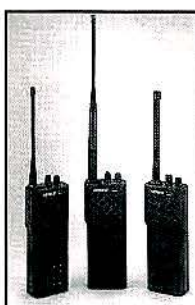
Circle (428) on Fast Fact Card

Disguised mobile antennas



The XXX-SB-150 line of AM/FM antenna replacements from **STI-CO Industries** covers 150MHz-174MHz without tuning. The VHF units, equipped with stainless-steel masts, are customized for select Chrysler, Ford, GM and Euro-Asian body styles, and include built-in broadcast couplers.

Circle (429) on Fast Fact Card



Portable two-way radios

The RTX portable two-way radio series from **Ritron** includes low-band, VHF and UHF models. The radios all feature an 11-

channel capacity, wideband operation, cloning capability, field programming and low-battery alert. Accessories include holsters, chargers, remote speaker mics and DTMF keypads.

Circle (430) on Fast Fact Card



UHF synthesized, programmable repeater

Ritron's RRX-450 synthesized, programmable repeater features CTCSS or DCS signaling, selectable input voltage for ac, and 12Vdc operation with battery charge and automatic battery cut-over. Capabilities include local radio test, duplexer delete and telephone interconnect. A temperature compensation circuit ensures stability during ambient temperature changes.

Circle (431) on Fast Fact Card



Mobile two-way radios

The RPM series of Patriot two-way mobiles from **Ritron** are available in lowband, VHF and UHF models. The synthesized, field-programmable radios include self-check diagnostics, a front-panel speaker and a dual-function LED.

Circle (432) on Fast Fact Card



Communication system analyzer

To calibrate, maintain, service or design two-way radios, cellular phones or pagers, the **Motorola R-2600** analyzer provides a versatile, dependable solution. Because of its "one-box" design, the unit performs many complex functions from the same piece of equipment.

Circle (433) on Fast Fact Card

Emergency medical radio

The new Midland Emergency Medical Services (MEMS) radio from **Midland International** is a compact, frequency-synthesized programmable FM two-way mobile for medical emergency applications. Available in 30W-90W output power for UHF, it offers as many as 320 channels, programmable in 16 groups. Operators use a UHF hand-held radio with a DTMF key pad to select channels and talk through the mobile radio.



816-241-8400, ext. 1690
Fax 816-920-1144

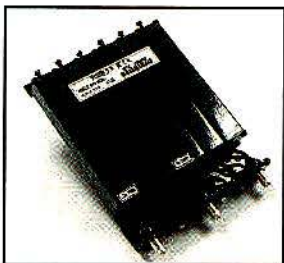
Circle (434) on Fast Fact Card



Preset dc power supply

The model PPS-4A from **Astron** allows the user to preset the voltage and current without actually loading the unit. The supply is completely solid-state and suitable for bench or rackmount operation. The unit delivers 0V-16V at 0A-4A and can be adjusted continuously throughout the output range.

Circle (435) on Fast Fact Card

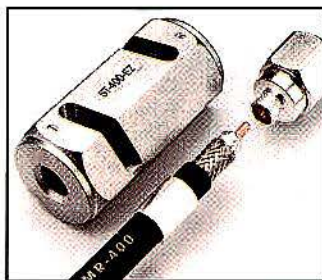


Band-reject duplexers

With 5MHz separation in VHF (4MHz UHF), this duplexer from **EPCOM** features low insertion loss and high TX/RX isolation.

El Paso Communication Systems
1630 Paisano Drive, El Paso, TX 79901
915-533-5119; Fax 915-542-4701

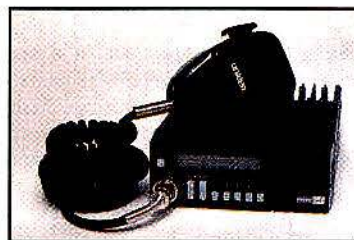
Circle (436) on Fast Fact Card



Solderless coax connector

Times Microwave Systems introduces the first Type N male crimp-style "solderless" connector for low-loss LMR-400 coax cable. The connector installs in minutes with the ST-400-EZ stripper and a standard hex crimp tool.

Circle (437) on Fast Fact Card



Dual-mode trunking mobile

Uniden America's SVS8025TSE alphanumeric trunking mobile is a full-featured 800MHz unit offering dual-mode, ESAS and LTR operation. Uniden specializes in the manufacture of wireless devices including two-way radios, pagers, cordless telephones, scanners and satellite receivers.

Circle (438) on Fast Fact Card

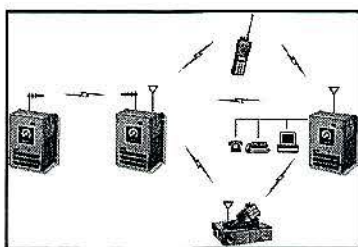


Cleaning pen

Zip away paper labels, masking tapes, bar code labels and adhesive residues with the TidyPen from **Micro Care**. The powerful ozone-safe solvent cleans easily and fast. A time-saver for repair shops, the pen is recyclable and non-toxic.

800-472-7373

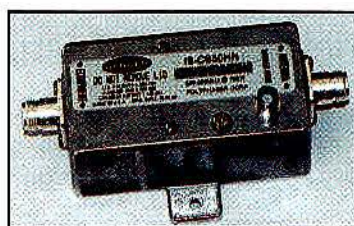
Circle (439) on Fast Fact Card



Telephone link

The SR-20 is the answer for permanent or emergency portable, mobile or fixed wireless connectivity. **Telepoint** offers flexibility and solutions. Call 800-333-6444 for more information on low-cost, low-capacity multi-access systems for voice, fax and data communications.

Circle (440) on Fast Fact Card



Coaxial protector for GPS

PolyPhaser introduces a coaxial protector for GPS receivers with active antennas. The IS-MR50LNZ+6 protects in-line amplifiers and GPS receivers, providing optimal protection for dc and RF paths on coax. With positive and reverse voltage protection, it exhibits low loss and low VSWR over a large bandwidth.

Circle (441) on Fast Fact Card



1996 Buyers' Guide

Tessco's 1996 Buyers' Guide features seven sections covering

infrastructure products, mobile and portable accessories, antennas, bench equipment and test and maintenance gear—with complete product specifications and guaranteed pricing built right in. It's available on a complimentary basis to qualified service organizations by calling 800-472-7373, faxing 410-472-7575 or visiting our web site <http://www.tessco.com>.



Pager/radio repair kit

The new 8100-1097 SMD repair kit from **A.P.E. South** contains materials for repairing Motorola pager and cellular products, including tweezers, probes, wetting solutions and solder remover.

305-451-4722; Fax 305-451-3374

Circle (443) on Fast Fact Card



SCADA, telemetry systems

Economical, easy-to-use, **ULTRAc** wireless SCADA and telemetry systems from **Zetron** feature PC-based centrals; use of existing radio systems; NEMA cases with battery backup; PLC monitor and control systems; PLC communication via MODBUS; and voice and paging alarms over phone or radio via SentiVoice and SentiDial product lines.

Circle (444) on Fast Fact Card

Readers' choice

Of all the new products and services in the October 1995 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

The Pathfinder 9600 from **RF Industries** is a 2W, high-speed, 9,600bps, UHF synthesized data transceiver. The unit is designed for applications requiring a rugged UHF wireless modem with

easy-to-use data interfaces. Standard data interfaces include a three-wire packetized mode for GPS, SCADA and telemetry applications.

Circle (500) on Fast Fact Card



TWO WAY RADIO BASE STATION 15 AMP POWER SUPPLY

Model SEC 1212 Features:

- ◆ Ultra Slim Line, Low Profile Cabinet
- ◆ Highly Regulated Output Voltage 13.85
- ◆ Industry Leading 3 year Limited Warranty
- ◆ 15 Amps Output Current ICS
- ◆ 12 Amps Continuous Output Current
- ◆ Overload, Short Circuit and Over Current Protected
- ◆ RFI Suppression/Low Noise
- ◆ Low Output Ripple<3mV
- ◆ 2" H X 7" W X 7.75L 3 lbs
- ◆ Solid State Design
- ◆ Switch Mode Technology

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Made in Canada by Samlex America, Inc.

Circle (51) on Fast Fact Card

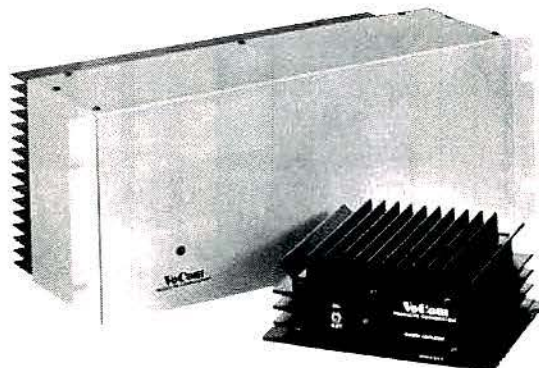
VoCom's RF Power Amplifiers

VoCom's AMPLIFIERS POWER OUTPUT:

- | | |
|-----------------|-----------------------------------|
| • VHF Low Band | 150 & 300 Watts |
| • VHF High Band | 25, 50, 100, 180, 300 & 500 Watts |
| • UHF Low Band | 25, 50, 100, 200 & 350 Watts |
| • 800 MHz | 40, 75 & 140 Watts |
| • 900 MHz | 35, 60 & 120 Watts |

VoCom's AMPLIFIERS ARE:

- FCC Type accepted
- Limited 5 year warranty
- Tuned to your specific input drive (100 mWatts & up) and frequency
- Protected for SWR, Temperature and Overdrive



VoCom Products Company, L.L.C.

Quality since 1979



1-800-USA-MADE
(1-800-872-6233)
FAX: 708-924-9078



Circle (52) on Fast Fact Card

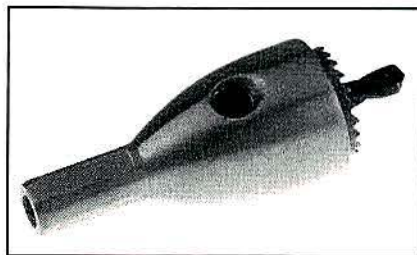
Protocol expands test capability for paging closed loop program

Advanced Signal has added the Telocator Alphanumeric Protocol (TAP) capability to its Closed Loop System Test program. The feature allows users to introduce paging data into a paging system without having to be physically located at the paging terminal. The Closed Loop System Test program is a Telocator Network Paging Protocol (TNPP) load generation program designed to aid in testing paging system reliability. The program can generate Golay, POCSAG and Flex

paging data, which can be input into a paging terminal's TNPP input port or into a Motorola Channel Interface Unit (CIU). Data can be generated in the form of test pages, simulated paging traffic (channel loading), a combination of test pages and channel loading, or channel loading on a live system. When used in conjunction with the company's Signalpro decoder, complete closed-loop testing can be accomplished.

Circle (451) on Fast Fact Card

Saw cuts hole in vehicle surface for installation of 3/4" hole mounts



The HS34 hole saw cuts a hole in a vehicle surface to allow the installation of industry-standard 3/4" hole mounts. The saw from Antenex is made from a single piece of hardened tool steel, so it will not break apart on the job. A self-centering pilot drill prevents the saw from "walking," and a 1/8" depth limit prevents damage to the underlying headliner yet is deep enough to cut through thicker aluminum surfaces on utility vehicles and some ambulances. The saw is designed for 3/8" chuck and is nickel-plated to prevent rusting.

Circle (453) on Fast Fact Card

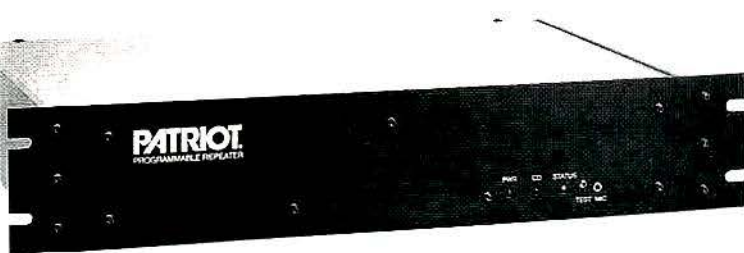
Spectrum analyzers provide performance for a variety of applications

Four spectrum analyzer models from B+K Precision provide performance and important features needed for a wide variety of applications. The analyzers are stable and relatively drift-free, their dynamic range is wide, the maximum signal input large, and they have tracking generators and audio demod. The analyzers can measure low amplitude signals with a measurement range of more than 113dB (-100dB to +13dBm). Optional accessories are a battery pack and a 75Ω/50Ω impedance matching adapter.



Circle (452) on Fast Fact Card

New Patriot Repeater Beats Kenwood TKR-820 In Laboratory Measurements and "Real World" Tests.



The complete line of Patriot two-way radios include synthesized, programmable portables and mobiles in the low band, VHF and UHF frequency bands.

We pitted our Patriot RRX Series programmable repeater against some strong competition. Our "Real World" on-site performance tests confirm lab measurements that the RRX has less receiver desensitization and higher adjacent channel rejection than the Kenwood TKR-820. This means, with the Patriot, you get more reliable communications with greater range, and fewer lost calls due to interference.

But, superior performance and specifications are not the only things that separate the Patriot repeater from the competition. It can also costs hundreds of dollars less and still offer these versatile features/options:

- 1-8 Watts or Optional 30 Watt Internal Amplifier
- CTCSS or DCS Signalling
- Selectable Input Voltage 110/220 VAC, 50-60 Hz
- 12VDC Operation w/ Battery Charge and Auto Cut-Over
- Duplexer Delete Option
- One Year Warranty
- Plus a variety of Interface Modules that enhance the functionality of the RRX Series Repeater
 - Telephone Interconnect Module
 - 4 Wire or 2 Wire Modules for Wireless Links
 - Telenex —Wireless Phone Line Extender

Put Patriot's dependability and performance to work for you today.
Call 800-USA-1-USA or fax (317) 846-4978

PATRIOT®

BY RITRON

MADE IN THE
USA

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Circle (53) on Fast Fact Card

New products

Data base station provides programmable 12.5kHz, 25kHz spacing

Motorola Land Mobile Product Sector's Quanstar data base station (DBS) provides high-speed data communications for Motorola's Private DataTAC networks. The 800MHz DBS combines flexibility, a compact design and a smaller footprint. Programmable 12.5kHz or 25kHz channel spacing allows for easier upgrades and system migrations. Both 100-20W and 20-

6W models are available. The station, complete with modem and radio frequency peripherals, can be housed in a 30-inch-wide cabinet. Designed to support rates to 19.2kbps, the Quanstar can provide full power in 10ms. Transmitter power can be set for customized communications coverage for mobile and portable terminals.

Circle (454) on Fast Fact Card

Portables targeted for mass market of business users



Low-cost, easy-to-use portables from Uniden are targeted to the mass market of business users who want a more consumer-based product. The SPH21, VHF radio and SPU21 UHF radio are both 2W, one-channel transceivers. They are available on any one of 16 frequencies, including the common "dot" channel frequencies. The radios are shipped complete with the transceiver, antenna, battery pack, belt clip and charger.

Circle (455) on Fast Fact Card

7/16 DIN to Type N connector adapters feature low VSWR



A series of 7/16 DIN to Type N connector adapters are designed specifically for cellular and PCS applications. By using a one-piece center pin, these adapters ensure low VSWR, typically less than 1.03GHz to 2GHz. Silver plating, fewer parts and high surface contact pressures minimize intermodulation generation. The adapters from Andrew include fully retractable coupling nut on DIN interface, small size and O-rings and gaskets that keep moisture out of the interface.

Circle (456) on Fast Fact Card

Antenna line expansion features higher gain, wider downtilt range

Hazeltine has added six models of SMR/cellular flat-panel antennas to its Phazar line. The antennas deliver high gain and include electronic downtilt options from 0° to 9°. A precision-stamped microstrip and an isolated center-feed yield intermodulation product levels averaging -151dBc. Optional Chameleon coverings provide camouflaged installations. The wideband, single-beam antennas are available in 80°, 90° and 105° beamwidths.

Circle (457) on Fast Fact Card

IT ALL ADDS UP TO THE WORLD'S FINEST TELEPHONE LINK.

The SR-64... it's the answer. Whether it's a permanent or emergency need for a phone line, a leased line point-to-point or multipoint 14.4 Kbps data transmission, it all can be airborne on the same system.

For more information, or a demo right over the phone, just give us a call.

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310-652-0777 Facsimile
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800-567-6664 Canada

TELEPOINT INC.

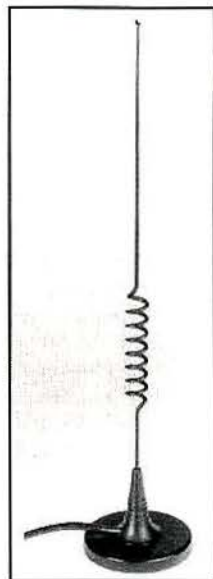
1022 S. La Cienega Blvd. • Los Angeles, CA 90035



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Circle (54) on Fast Fact Card

Magnet-mount antennas improve hand-held cellphone performance



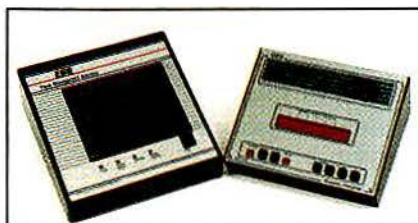
Antenna Specialists Division of **Allen Telecom Group** has added the ASPD 1984 series of magnet-mount mobile cellular antennas. The antennas have a maximum power output rating of 100W and an omnidirectional gain of 3dB when mounted on a vehicle's roof. The broadband antennas cover the cellular frequency range without tuning. The antennas have a VSWR or 1.9:1 or better.

Because the antennas adhere to a vehicle with a powerful magnet, the antennas can be moved easily from vehicle to vehicle.

Circle (458) on Fast Fact Card

Product group covers ANI, remote monitoring, control applications

Communications Electronics Specialties (CES) has released the ARIS group of products that offers a complete multifunctional system for ANI radio identification, remote monitoring, alarm and control applications. The products are designed for existing or new, conventional or trunked radio system installations. The products are compatible with many international signaling protocols, including 5-tone sequential, *n*-tone sequential, hexadecimal sequential (HSC) and DTMF. The group includes a minia-



ture mobile or portable encoder, multiple input encoder, display consoles and computer-aided dispatch software.

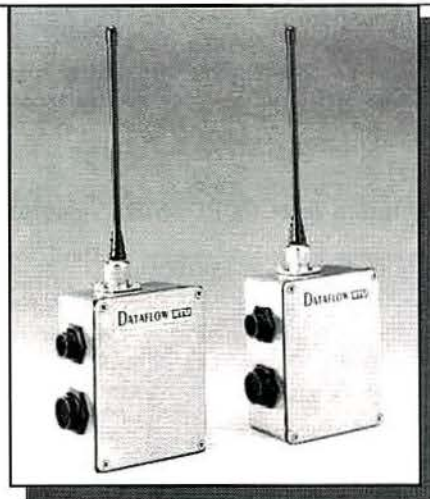
Circle (459) on Fast Fact Card

Universal paging encoder filters out electromagnetic interference

The model 15T Pager Tester from **Zetron** is a universal paging encoder. The shielded, metal enclosure acts as a barrier to radiated emissions, allowing accurate measurement of pager receiver sensitivity. Line filters on all inputs and outputs serve to prevent EMI in both directions. Used in conjunction with an RF signal generator, the unit will test a wide range of analog and digital pagers, including two-tone, Reach, DTMF, HSC, 5/6-tone, POCSAG, NEC and Golay.



Circle (460) on Fast Fact Card



The Dataflow® RTU is a commercial version of a product successfully designed and manufactured by Ritron for the U.S. Department of Energy's Sandia Laboratories.

Call 1-800-USA-1-USA for more information.

Ritron, Inc. • 505 West Carmel Drive • Carmel, IN 46032
(317) 846-1201 • Fax (317) 846-4978
<http://www.ritron.com>

DATAFLOW® RTU
Analog & Digital I/O RF Telemetry System

Ritron RF Telemetry—The Wireless Connection

WIRELESS DATA SOLUTIONS

Connect your industrial instrumentation and control signals from multiple sites with the Dataflow RTU RF Telemetry System. The Dataflow RTU serves as a cost-effective, 2-way wireless solution for your remote monitoring and control applications.

Each Dataflow RTU is ready for operation and includes a unique micro-power RTU and plug-in synthesized radio transceiver module. A common serial programming interface configures both the RTU and radio transceiver.

Dataflow RTU standard features include:

- Watertight Housing and Connectors (4.5" x 3.5" x 2.2")
- 2/5 Watt, Programmable RF Transceiver
- Multiple Analog and Digital Inputs and Outputs
- MODBUS Protocol, RS-485 Serial Communications Port for System Expansion
- Digital Repeater Mode Allows Extended System Range
- Solar/Battery Powered Options for Remote Sites



Circle (55) on Fast Fact Card

TRANSMITTER LOCATION

Direction Finding System Tracks Down

- Stuck Microphones
- Cable TV Leaks
- Jammed Repeaters & Cell Sites

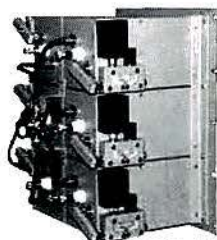
Models available with computer interface, synthesized speech, for fixed or mobile use, covering 50 MHz to 1 GHz. Call or fax for details



Circle (56) on Fast Fact Card

EMR Corp. TRUNKING COMBINING SYSTEMS

VHF - UHF - 800 & 900 SMR TRANSMITTER COMBINERS

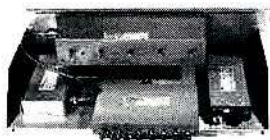


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REMOVE HOLDING LINES

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- HIGH GAIN
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- 2 TO 64 PORTS
- COMPACT DESIGN



Contact EMR for combining systems in any band from 66 MHz to 2 GHz

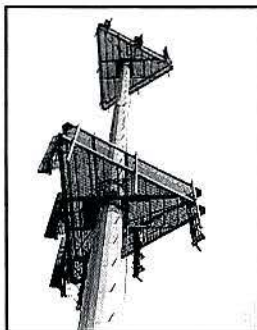
EMR CORPORATION

22402 N. 19th AVENUE - PHOENIX, ARIZONA 85027
TEL: 602-581-2875 OR 800-796-2875 FAX: 602-582-9499

Circle (57) on Fast Fact Card

New products

Monopoles feature sectionalized construction for easy on-site assembly, low visual impact



A line of monopoles from Sabre Communications are designed specifically to support antenna loadings for ESMR, microwave, cellular and PCS applications. The monopoles extend as high as 80 feet and are constructed of tapered sections for easy on-site assembly and low visual impact. Design options include service platforms, antenna support brackets, step bolts, conduit hubs, reinforced hand holds at proper

locations and a pole cap. Shafts are constructed of high-strength steel with minimum yield strength of 50,000psi and tensile strength of 70,000psi. Available finishes include self-weathering steel, hot-dip galvanized, prime-coated for field painting or factory-applied baked-on finish coat.

Circle (461) on Fast Fact Card

EEPROMs provide trunking conversion for mobiles

IDA offers LTR trunking conversion EEPROMs for various Motorola and Motorola Radius mobile radios. The replacement EEPROMs are available for popular models in the 400MHz, 800MHz and 900MHz bands. LTR conversion of Privacy Plus mobile phones is also being offered. An inexpensive programming kit is required to program the converted mobiles. Post-conversion features include group scan, TX time-out timer, trunked or conventional operation, CTCSS and CDCSS, block decode and automatic channel acquisition.

Circle (462) on Fast Fact Card



Dedicated solution tests CDPD, MDBS equipment



Hewlett-Packard has introduced a dedicated test solution for installing and maintaining RF infrastructure systems for CDPD and mobile database stations (MDBS). The solution is available as an option to HP's 8921A RF communications test set, which evaluates the performance of CDPD

RF base station equipment. Fitted with the option, the test set can quickly test key RF parameters for both forward-channel transmitter and reverse-channel receiver to assess the quality of a signal. It also verifies proper sniffer receiver operation. The option also can decode and display packet-data units for verification of parameters set in the MDBS.

Circle (463) on Fast Fact Card

Cellular performance monitor provides vehicle-based analysis



The LT100 cellular performance monitor from **Comarco Wireless Technologies** is designed for vehicle-based

daily monitoring of cellular and PC networks. The ergonomically designed "heads-up" control unit has a direct-sunlight-viewable color display. The unit includes an integral FastScan wideband receiver and an external calling module. Displays include on-line call with adjacent energy and SAT, best server with DCC, setup and channel set detail, handoffs, and advanced C/I and C/A interference profiles. The LT100 is available immediately for AMPS/TDMA network operation with GSM, CDMA and PCS1800/1900 models under development.

Circle (464) on Fast Fact Card

Weather radio, repeater allows full DTMF control from remote location

The Weather Eagle 200 NOAA weather alert radio from **Thunder Eagle** supports full DTMF control of the radio from a remote location, allowing a user in the field to play back warnings or live weather radio through an existing two-way system. An electronic sensor automatically prevents the unit from interfering with priority radio commu-

nications. The remote control and repeater interface includes date and time stamp, current time-of-day and reset. Other features include adjustable time-out timer, adjustable audio output, busy input from the two-way system and PTT output. The unit fits a standard 19" equipment rack.

Circle (465) on Fast Fact Card

Enhanced digital communications test set allows in-service testing



Tektronix has expanded the capabilities of its CMD57 digital communications test sets. The test system for GSM, DCS 1800 and PCS 1900 base stations now incorporates an in-service test capability that allows network operators to test without disconnecting from the network. The CMD57 is used by PCS 1900 network operators to perform testing of GSM base station transceiver (BST) transmitters and receivers. The unit occupies only one of the GSM network cell's RF carriers and makes frequency-selective measurements. The test set suppresses all other channels with its selective receiver to avoid corrupting the measurement results.

Circle (466) on Fast Fact Card

Ritron RF Transceivers—The Wireless Connection

WIRELESS SOLUTIONS

Synthesized, programmable RF transceivers for OEM and custom wireless data and voice applications. Utilizing the latest in SMD design and microprocessor technology, the DTX RF transceiver offers reliability and low-cost without sacrificing features and performance.

The DTX Series of RF transceivers includes a complete stand-alone module consisting of an RF transceiver and microcontroller-baseband module in an enclosure.

And for lower cost and highly integrated applications, where the user is prepared to supply RF synthesizer data and conditioned signals, the DTX RF transceiver board is available separately.

DTX Transceiver Standard Features:

- Low Cost
- Small Size (DTX module 1.24"H x 4.5"L x 2.5"D)
- Synthesized, PC Programmable
- 2 or 5 Watt Output
- 11 Channel Capability
- CTCSS/DCS Signalling



**For more information
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(317) 846-1201 • Fax (317) 846-4978

Email: ritron@ritron.com
<http://www.ritron.com>

RITRON, INC.

Circle (58) on Fast Fact Card

Spectrum A New Dimension In Repeaters

Spectrum Repeaters & Base Stations provide a New Dimension in 'on the air' performance that lasts — year after year, even under the worst conditions. Thousands of our units have been operating all over the world for over 20 years...with excellent reports.

Our friendly sales and technical team are very accommodating and happy to discuss the details of your system. Every customer is important to us — you're not just a number, as you often are with our competitors! Give us a call or FAX today regarding your Repeater, Base, or RF Link needs.

FEATURES

- Deluxe Models with Full Panel Metering & Controls
- Low Cost Basic Units
- Super Sensitive & Selective Receivers
- RX Helical Resonator Option
- Excellent Quality Audio
- 100% Duty Cycle
- Provision for: Interconnect, DTMF Remote Control, Tone Panel, etc.
- Also Available: Duplexers, Cabinets, Antennas, etc.



**S-7R
Low Cost
Repeater**

**New SCR 1400
150W Rptr./Base**

**VHF/UHF
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The Alpha series MCR remotes allows you to remote control Motorola's Maxtrac, RadiusGM300, Kenwood TK630, TK730, TK830 and Midland's Syn-Tech XTR radios over any two wire voice grade circuit.

The Alpha series remotes provide an LCD readout for channel number, up to 99, and a ten character channel name, channel up and down controls, speaker volume control and intercom capability between parallel remotes and the radio. Each remote also provides controls and LED indicators for PTT, monitor, scan and privacy functions.

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- Programmable ten character name per channel.
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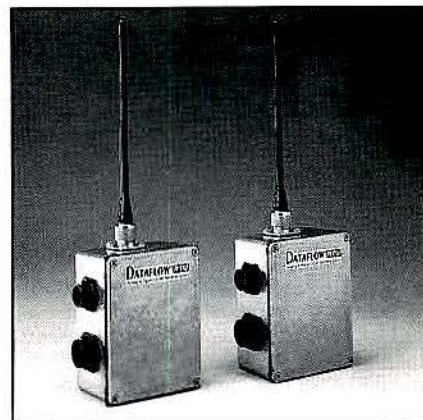


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Circle (60) on Fast Fact Card

New products

**Remote telemetry unit provides
interface to industrial devices**



The DataFlow RTU wireless telemetry system from **Ritron** delivers industrial instrumentation signals via FM radio. The RTU provides wireless control, monitoring or remote metering at distant or remote locations and offers a cost-effective alternative to microwave links, leased telephone lines and hardwire. The unit has an adjustable 2W-5W transmitter that operates on either VHF (136MHz-175MHz) or UHF (406MHz-420MHz, or 450MHz-512MHz) frequency bands. It uses synthesized radio transceivers that are easily programmed in the field with a personal computer and software. An RTU system at 2W, with directional antennas and 50' towers, can have an effective range of 20 miles over level terrain.

Circle (467) on Fast Fact Card

**New database improves accuracy
of radio system design software**

SoftWright has released an updated United States topographic database for use in its Terrain Analysis Package (TAP) radio system design software. The database contains information digitized entirely from the 7 1/2" quadrangle maps and using a point spacing of 30 meters.

Circle (468) on Fast Fact Card

Distribution

VCP International is now selling the Otiva side-display numeric pager from Panasonic. VCP is also a stocking distributor for Panasonic's other pager models, parts and batteries.

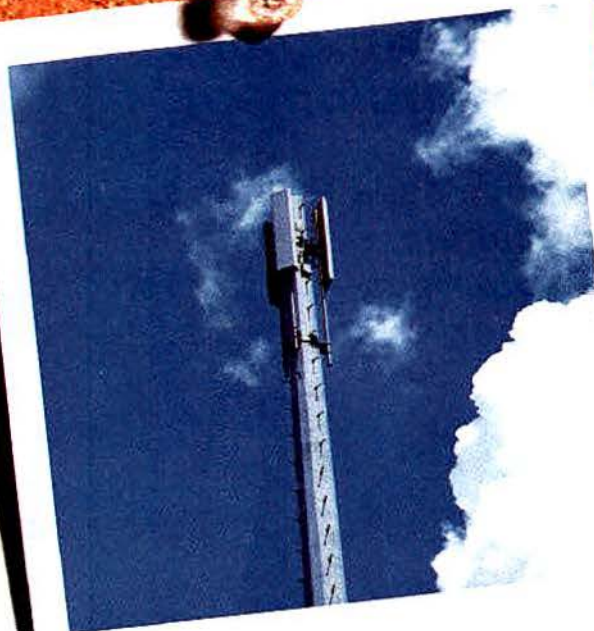
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Dealer Sales and Distribution

Circle (62) on Fast Fact Card

Literature

Brochure covers products for electrical market

ERICO introduces an eight-page brochure describing grounding, bonding and connecting product lines. Brand names include Cadweld, Eritech, Esp, Flexibar and Gem. Information on the company's engineering and technical support using ERICO products is provided.

Circle (201) on Fast Fact Card

Catalog contains refurbished test equipment

The **ValueTronics International** catalog lists refurbished test equipment manufactured by Hewlett-Packard, Fluke, Tektronix, Marconi, IFR and other manufacturers. The catalog includes spectrum analyzers, generators, oscilloscopes, communication test sets, meters, counters and recorders. All equipment has a warranty and comes with standard accessories.

Circle (202) on Fast Fact Card

Brochure features subminiature coaxial connectors

A four-page brochure from **Applied Engineering Products** features subminiature coaxial connectors that meet the 75Ω requirement and can fit in confined spaces. The products are ISO-9001 certified and qualified to MIL-C-39012.

Circle (203) on Fast Fact Card

Brochure offers line of anechoic chambers

Lindgren RF Enclosures introduces an eight-page brochure on its Facts (Free-space Anechoic Chamber Test-site System) line of anechoic chambers, as well as full-service capabilities in chamber design and installation. The Facts line provides sites for electromagnetic compatibility (EMC), recognizing EMC testing requirements. Chambers can be constructed from double-steel-laminated (DSL) shielding panels or from welded-steel-module (WSM) shielding.

Circle (204) on Fast Fact Card

Bulletin on digital techniques for mobile service

The **Telecommunications Industry Association (TIA)** has published a bulletin titled, "Radio Control Protocol" that provides details of the Associated Public-Safety Communications Officials-International Project 25 Radio Control Protocol (APCO Project 25) and information on emerging digital techniques for land mobile service.

Circle (205) on Fast Fact Card

Literature lists data on radiation monitors

Wandel & Goltermann has released a two-page data sheet on the EMR-10 and EMR-11 radiation monitors designed to measure magnetic and electrical field strength in the workplace. The EMR-10 has a frequency range of 30kHz to 30MHz, and the EMR-11 has a range of 100kHz to 3GHz, suitable for measuring electrical fields.

Circle (206) on Fast Fact Card

Catalog contains test, repair products for electronics

Jensen Tools' 96-page catalog introduces a line of modular electronic test and assembly workbenches by BenchMark and two new DMM service kits by Fluke. These products join the current Jensen line, including inch and metric tools, test equipment, SMT soldering and rework stations, and static control products.

Circle (207) on Fast Fact Card



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Bill Kuznicki, Motorola Paging Products Group

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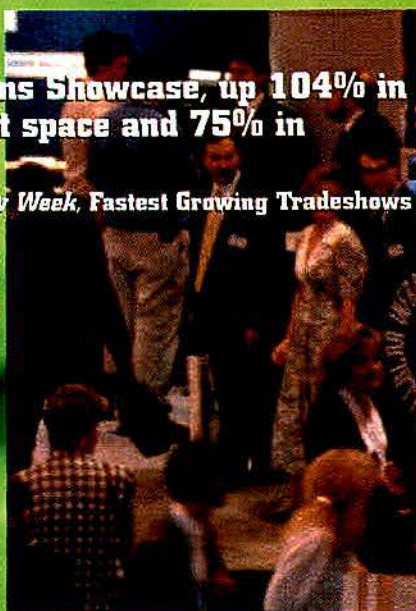


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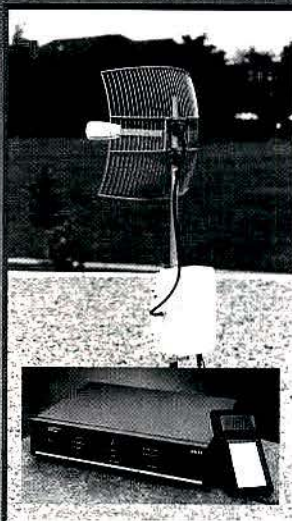
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People



Jeffrey Gillum



Dick Radawicz



Bobby Thompson

Jeffrey Gillum, avionics test equipment marketing manager for IFR Systems, Wichita, KS, advances to director of international sales.

Dick Radawicz, director of Satcom Products for Tecom, Chatsworth, CA, will manage the newly opened Tecom office in Boulder, CO.

Bobby G. Thompson leaves Motorola's Field Service Division, Scottsdale, AZ, as western region operations manager to start a consulting firm, Bobby G. Thompson & Associates, Phoenix, AZ.

Thomas Prosia leaves Covia Technologies, Chicago, as vice president of sales, marketing and communications to join Coral Systems, Longmont, CO, as vice president of marketing.

Brian Danzis, president of BDS Communications and Bridan Communications, Mechanicsburg, PA, joins American Tower Systems, West Palm Beach, FL, as vice president of the mid-atlantic region.

Michelle Schembre leaves PhoneTel Technologies, Cleveland, as senior accountant to join Information Radio Technology (InfoRad), Cleveland, as accounting manager.

Robert P. Badavas leaves Chipcom, Southborough, MA, as senior vice president to join Cerulean Technology (formerly PacketCluster Systems), Marlborough, MA, as chief executive officer.

Joseph B. Costello, president of Cadence Design Systems, San Jose, CA, joins the board of directors of Racotek, Minneapolis.

Michael Schwimmer, director of business development for Wireless Telecom (WTI), Aurora, CO, advances to vice president of business development.

Thomas J. Wiseman, senior project manager for Arcnet, Holmdel, NJ, advances to director of services.

Changes at Mitsubishi Wireless Communications, Braselton, GA:

Doug Barker leaves Georgia-Pacific, Atlanta, as electronic data interchange supervisor to join Mitsubishi Wireless Communications as new business development manager.

Bill Mabry leaves Uniden America, Atlanta, as regional sales manager of the cellular division to join Mitsubishi Wireless Communications as district sales manager.



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L etters from readers

Heavy equipment radio installations:

After reading Donald Koehler's April 1996 article, "Installation Tips for Heavy Equipment," regarding heavy equipment radio installations, I can only conclude that Don is a very skilled and clever craftsman. I am compelled, however, to voice my concern to the many other readers regarding the radio mounting configuration he advocated.

His suggestion of attachment to the "cab risers" (roof supports) in many instances could be a direct violation of State (and possibly Federal) OSHA regulations concerning modifications of safety equipment, due to the fact that we have found the roof supports in all newer equipment

comprise a roll cage protective structure. In some instances, the manufacturers provide pre-installed, tapped inserts that should be used. If not, I strongly recommend that all technicians and installers involved in similar installations seriously consider the possible liability situation and first consult the equipment manufacturer, then their local regulating agency before attempting any drilling into roll cage protective assemblies.

Floyd H. Miltz
Service Manager
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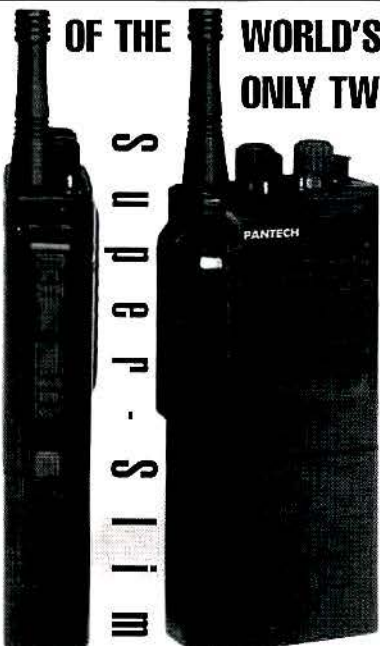
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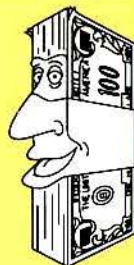
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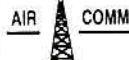
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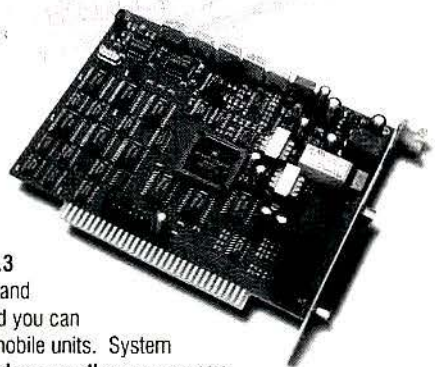
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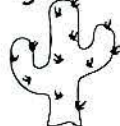
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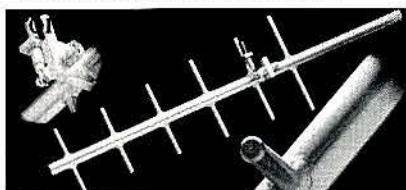
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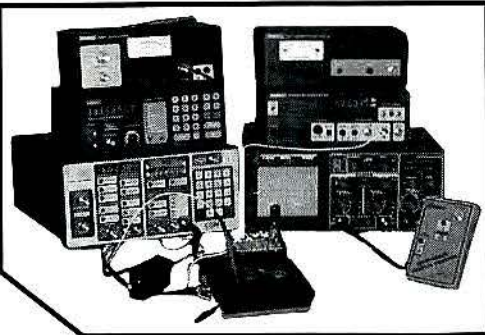
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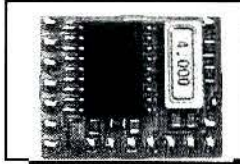
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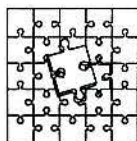
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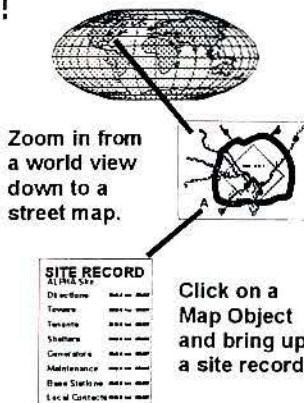
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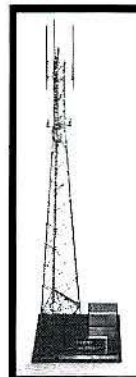
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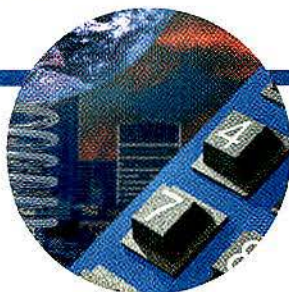
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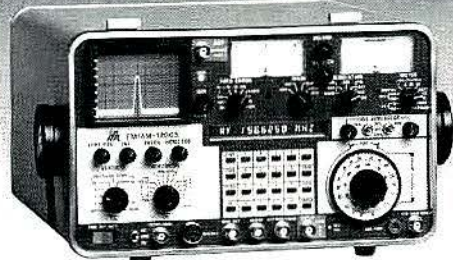
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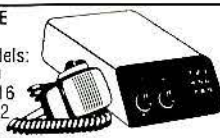
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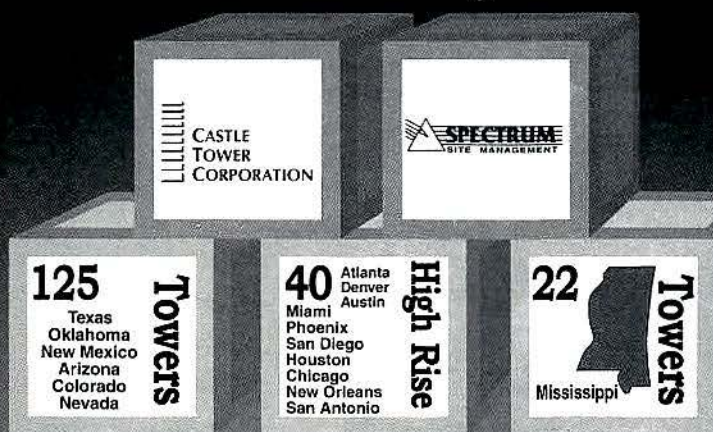
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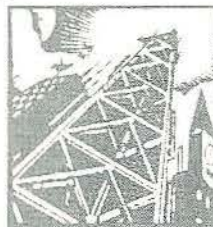
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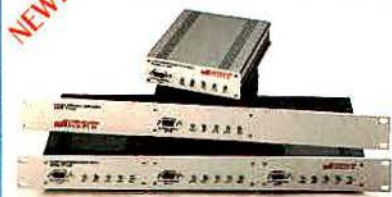
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